TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST FOR COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-459 (HEWLETT-PACKARD MODEL 5328A/E42) (NSN 6625-01-061-8928)

HEADQUARTERS, DEPARTMENT OF THE ARMY

MARCH 1979

Technical Manual

No. 11-6625-2941-14 + P

HEADQUARTERS,
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Washington, DC 28 March 1979

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REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 located in the back of the manual. simply tear out the self-addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Forms 2028-2 in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, New Jersey 07703.

In either case a reply will be furnished direct to you.

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. The manual was not prepared in accordance with military specifications; therefore, the format has not been structured to consider categories of maintenance.

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SAFETY CONSIDERATIONS

GENERAL

This is a Safety Class I instrument. This instrument has been designed and tested according to IEC Publication 348, “Safety Requirements for Electronic Measuring Apparatus.”

OPERATION

BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage and the correct fuse is installed (see Section II). Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

SERVICE

Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by qualified service personnel.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

WARNING

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTOTRANSFORMER (FOR VOLTAGE REDUCTION] MAKE SURE THE COMMON TERMINAL IS CONNECTED TO THE EARTHED POLE OF THE POWER SOURCE.

WARNING

BEFORE SWITCHING ON THE INSTRUMENT, THE PROTECTIVE EARTH TERMINALS OF THE INSTRUMENT MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

WARNING

THE SERVICE INFORMATION FOUND IN THIS MANUAL IS OFTEN USED WITH POWER SUPPLIED AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

CAUTION

BEFORE SWITCHING ON THIS INSTRUMENT:

1. MAKE SURE THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SOURCE.
2. ENSURE THAT ALL DEVICES CONNECTED TO THIS INSTRUMENT ARE CONNECTED TO THE PROTECTIVE (EARTH) GROUND.
3. ENSURE THAT THE LINE POWER (MAINS) PLUG IS CONNECTED TO A THREE-CONDUCTOR LINE POWER OUTLET THAT HAS A PROTECTIVE (EARTH) GROUND. (GROUNDING ONE CONDUCTOR OF A TWO-CONDUCTOR OUTLET IS NOT SUFFICIENT.)
4. MAKE SURE THAT ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE (NORMAL BLOW, TIME DELAY, ETC.) ARE USED FOR REPLACEMENT. THE USE OF REPAIRED FUSES AND THE SHORT-CIRCUITING OF FUSE HOLDERS MUST BE AVOIDED.

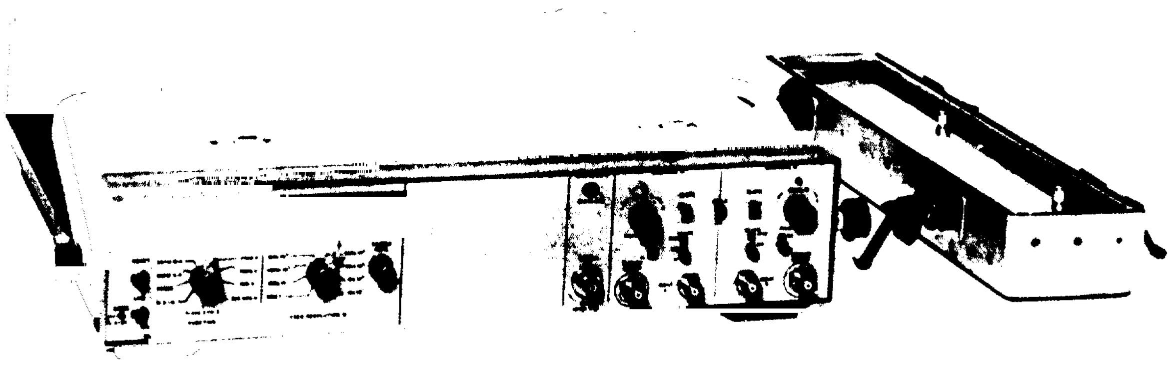


Figure 1-1. Model 5328A 500 MHz Universal Frequency Counter

SECTION O

INTRODUCTION

0-1. SCOPE

This manual describes Counter, Electronic, Digital Readout AN/USM-459 and provides instructions for operation and maintenance. Throughout this manual, the AN/USM-459 is referred to as Hewlett-Packard Model 5328A Counter.

0-2. INDEXES OF PUBLICATIONS

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions,changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

0-3. FORMS AND RECORDS

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A and DLAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

0-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

EIR’s will be prepared using Standard Form 368 (Quality Deficiency Report). Instructions for preparing EIR’s are provided in TM 38-750, The Army Maintenance Management System. EIR’s should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

0-5. ADMINISTRATIVE STORAGE

Administrative storage of equipment issued to and used by Army activities shall be in accordance with paragraph 2-26.

0-6. DESTRUCTION OF ARMY ELECTRONICS MATERIEL

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2

SECTION I
GENERAL INFORMATION

1-1. SCOPE OF MANUAL

1-2. This manual provides operating and service information for the Hewlett-Packard Model 5328A/H42 500 MHz Universal Frequency Counter. (In this manual its name will be abbreviated to “5328A” or “counter”.) A separate operators booklet contains condensed operator instructions.

1-3. This manual is divided into eight sections as listed and described below:

Section I	GENERAL INFORMATION — Describes the counter, lists specifications, lists items supplied, lists items required, but not supplied, describes applications, and lists recommended maintenance and test equipment.
Section II	INSTALLATION — Provides instructions for unpacking, inspection, preparation for use, preparation for reshipment, and preparation for storage.
Section III	OPERATION — Provides operator instructions including frequency, measurement of input signal: time period, time period average, time interval, time interval average, and ratio between frequencies of two input signals.
Section IV	THEORY OF OPERATION — Covers a. description of the general operating principles of the counter with reference to block and schematic diagrams of each assembly.
Section V	MAINTENANCE — Contains maintenance and service information, including a list of assemblies, recommended test equipment, performance checks, and adjustment. Troubleshooting procedures and flowcharts are included in this section.
Section VI	REPLACEABLE PARTS — Provides a complete list of replaceable parts and parts ordering information.
Section VII	MANUAL CHANGES — Contains information on manual changes.
Section VIII	CIRCUIT DIAGRAMS — Contains schematic diagrams and component locating illustrations.

1-4. DESCRIPTION

1-5. The 5328A counter can be used to measure frequency, period, period average, time interval, time interval average, and ratio. The 5328A provides a 9-digit LED display, display storage, and leading zero blanking. Decimal point and unit readouts are displayed automatically. Two independent selectable input channels are provided for time interval measurements. Each input channel has an attenuator, trigger slope selector, level control, ac or dc coupling, and an oscilloscope marker output. Rear panel connectors provide a gate output, one- and 10-megahertz output, and an input for an external frequency standard. An ARM switch on the rear panel allows arming by the signal being measured (switch OFF) or by another input signal (switch ON).

1-6. INSTRUMENT IDENTIFICATION

1-7. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), which is located on the rear panel. The 4-digit serial prefix identifies instrument changes. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument. Instruments having higher serial prefixes are covered with a “Manual Changes” sheet included with this manual.

1-8. APPLICATIONS

1-9. Specific applications information is provided in Section III of this manual. The general application features of the 5328A are described in the following paragraphs.

1-10. The high sensitivity, frequency range, and signal conditioning controls (see Table 7-3) make the 5328A suited for a wide range of applications.

1-11. The rear panel controlled "ARM" feature of the 5328A is useful in applications such as burst frequency measurements, and pulse ampltiude measurements.

1-12. The 5328A single-shot resolution of 100 ns meets the requirements for applications such as mechanical and electromechanical device (relays) timing, time of flight measurements (ballistics), sonar ranging, radio ranging, and navigation.

1-13. Using time interval averaging, time intervals as short as 100 picosecond, with resolution to 10 picosecond may be measured. Applications include coaxial cable length measurements, phase measurements, logic timing measurements, and integrated circuit propagation delay measurement.

1-14. Full bandwidth, sensitivity, and signal conditioning of the Channel A, B, and C input amplifiers is provided for ratio and totalizing measurements.

1-15. The 5328A HP-IB Interface is able to output measurement data and be controlled (fully programmed) via the Hewlett-Packard Interface Bus (HP-16). The 5328A may be interfaced to HP-IB compatible instruments, calculators, or computers by interconnecting with an HP-IB cable.

1-16. EQUIPMENT SUPPLIED AND ACCESSORIES AVAILABLE

1-17. Table 7-7 lists equipment supplied with the 5328A and Table 7-2 lists accessories available, The Service Kits listed in Table 1-2 are described in Section III.

Table 1-1. Equipment Supplied

DESCRIPTION	HP PART NUMBER
Detachable Power Cord 231 cm (7 1/2 ft.) long	8120-1348
Extender Board, 18 pin	05328-62016

Table 1-2. Accessories Available

DESCRIPTION	HP PART NUMBER
HP Interface Bus Interconnect Cable	10631A, 914 mm (3 ft. long) 10631B, 1828 mm (6 ft. long) 10631C, 3656 mm (12 ft. long) 10631D, 0.5 m (1 1/2 ft. long)
Front Handle Kit Rack Flange Kit (for instruments without handles) Rack and Handle Kit (installation instructions included with above kits)	5061-0088 5061-0076 5061-0082
Service Kit: Function Selector and ROM Kit	05328-82004

1-18. SPECIFICATIONS

1-19. *Table 1-3* lists detailed specifications for the 5328AF/096.

Table 1-3. 5328A Counter Specifications

GENERAL

Power Requirements: 115 or 230 volts 60 or 400 Hz ac.
Display: Nine-digit LED.
Sample Rate: Variable from less than 2 milliseconds to HOLD.
Arming: Rear panel ARM (ON-OFF) switch. Refer to operation for details.
Blanking: Unwanted zeros to left of most-significant-digit are suppressed.
Hold: HOLDS count between samples.
Trigger Light: Indicates input is above trigger level.

PROGRAMMABLE OPERATION (CHANNELS A AND B)

Includes independent selection of coupling, trigger slope, trigger level, and attenuator for each channel. Separate/Common A switch is programmable. Also, an invert feature switches Channels A and B; useful in all functions except Ratio B/A.
Trigger level is programmable in 10 mV steps in X1; 100 mV in X10; IV in X100.
Trigger level accuracy under remote control:
X1: ±35 mV
X10: ±350 mV +2% of trigger level
X100: ±3.5V +2% of trigger level

Input Characteristics

Sensitivity: 15 mV rms, 0—35 MHz (decoupled 20 Hz—35 MHz (ac coupled)
50 mV rms, 35 MHz—100 MHz
Minimum pulse width 5 ns, 140 mV p-p.
Coupling: ac or dc switch selectable.
Impedance: 1 MΩ II <70 pF.
Trigger Level: Variable over ±2.5 volts times attenuator setting with 0 volt preset position.
Trigger Slope: Independent selection of + or - slope.
Attenuators: X1, X10, X100.
Dynamic Range: 25 mV to 1V rms times attenuator setting, 0—35 MHz; 50 mV rms times attenuator setting, 35 MHz to 100 MHz
Maximum Input:
dc coupled, X1: 250V rms, dc — SO kHz
1.25×10^7 V rms/freq., 50 kHz—2.5 MHz
5V rms, 2.5 MHz—100 MHz.
dc coupled, X10 and X100: 250V rms, dc 5 MHz 1.25 x 109V rms/freq., 5—100 MHz
ac coupled: 200V (peak ac + dc), 0-20 Hz; same as dc coupled above 20 Hz.
Channel Input: Separate or Common A.
Marker Outputs: A and B channel Schmidt trigger outputs available on front panel; 0 to 300 mV levels into 50Ω; <20 ns delay.

Frequency Measurements

Frequency A
Range: 0—100 MHz direct count.
Resolution: 1 MHz to 0.1 Hz in decade steps.
Accuracy: ±1 count ± time base error.
Display: Hz, kHz, MHz.

Period Measurements

Period A
Range: 0—10 MHz
Resolution: 10 ns to 0.1s in decade steps.
Accuracy: ±1 count ± time base error ±trigger error*
Display: ns, μs, ms.

Period Average A
Range: 0—10 MHz
Resolution: 100 ns—.01 ps in decade steps.
Accuracy: ±1 count displayed ± time base error

$$\pm \frac{\text{trigger error*}}{\text{no. of periods averaged}}$$

Display: μs, ns

Time Interval Measurements

Time Interval A to B
Range: 100 ns to 10^8 seconds
Resolution: 100 ns to 1-second in decade steps.
Accuracy: ±1 count ± time base error ± trigger error*
Display: μs, ms, s.

Time Interval Average A to B
Range: 0.1 ns to 10 seconds
Resolution:

$$\pm \frac{100\ \text{ns}}{\sqrt{\text{no. of intervals averaged}}} \pm 10\ \text{ps}$$

Accuracy:

$$\pm \frac{100\ \text{ns} + \text{trigger error*}}{\sqrt{\text{no. intervals averaged}}} \pm 2\text{ns} \pm \text{time base error}$$

Minimum Dead Time: 150 ns from one STOP to next START
Maximum Repetition Rate: 10 MHz.
Display: μs, ns.

Ratio Measurement

Ratio B/A, or C/A
Range: A: 0—10 MHz
Range: B: 0—100 MHz
Range: C: 30—500 MHz
Resolution: 1 part in $\frac{B}{A}$ x N
Accuracy: ±1 count of B or C ± trigger error* of A times frequency of B or C (N>1) For N=1, add 12 ns times frequency of B or C.

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* Trigger error is <0.3% of one period for sine waves of 40 dB S/N or better and amplitude equal to sensitivity of counter. For any wave shape, trigger error is than then:

$$\frac{\pm 2 \times \text{peak noise voltage}}{\text{signal slope}}$$

$$\left(\text{or } \frac{\pm .0025\ \mu s}{\text{signal slope in V}/\mu s} \text{ for 40 dB S/N}\right)$$

Table 7-3. 5328A Counter Specifications (Continued)

CHANNEL C

Input Characteristics

Range: 30 MHz to 500 MHz direct count
Sensitivity: 15 mV rms, 30 MHz—500 MHz
Trigger level: 0 volts
Impedance: 50Ω nominal
Maximum Input: 5 volts rms
Input protection: Input BNC fused; accessible from front panel. protected to 200 volts peak.
overload Indicator: flashing indicator warns of potential overload conditions.
Resolution: 1 MHz to 0.1 Hz in decade steps
Accuracy: ±1 count ± time base error
Display: Hz, kHz, MHz

TIME BASE

Outputs: 1 MHz and 10 MHz available at rear panel BNC in standby and operate modes
Output level: 1 volts rms into 50Ω
External Input: Operates from 1, 2.5, 5, and 10 MHz inputs at 1V rms.
Input impedance 1 KΩ||<30 pF
Counter automatically switches to external mode when external input is present.
Oscillator Aging Rate: <5x10^{10}/day after 24-hour warmup. Oscillator oven is energized when power cable is connected to line voltage.

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section provides instructions for unpacking, inspection, preparation for use, shipment, and storage.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the counter for visible damage (scratches, dents, etc.). If the counter is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual). Keep the shipping carton and packing material for the carrier's inspection.

2-5. PREPARATION FOR USE

CAUTION

Before connecting this instrument to an ac power line, be sure that the 115—230-volt line selector switch on the rear panel is set to the proper position and proper line fuse is installed (see below).

2-6. Power Requirements

2-7. This instrument can be operated on single phase 115 or 230 (-10%. +5%) volts ac. Power required is approximately 100 VA maximum. To avoid instrument damage, the rear panel line selector switch must be set to the correct position and the correct fuse (as labeled on the rear panel) must be installed. See Section III for rear panel features photograph. When shipped, the switch is set to 115-volt ac operation.

2-8. Fuse Replacement and Installation

2-9. Two fuses are supplied with the instrument. The instrument is shipped with a 2.0 ampere fuse installed for 115- volt operation. To change the instrument for 230-volt operation disconnect the ac power cable, set the line selector switch and install the 1.0 ampere fuse.

2-10. Power Cables

WARNING

TO PROTECT OPERATING AND SERVICING PERSONNEL, THIS INSTRUMENT IS EQUIPPED WITH A THREE-PIN POWER RECEPTACLE. THE CENTER PIN OF THE RECEPTACLE CONNECTS THE INSTRUMENT CHASSIS AND PANELS TO EARTH GROUND WHEN USED WITH A PROPERLY WIRED THREE CONDUCTOR OUTLET AND POWER CABLE. IMPROPERLY GROUNDED EQUIPMENT CAN RESULT IN HAZARDOUS POTENTIALS BETWEEN EQUIPMENTS.

2-11. To accommodate the different power receptacles used throughout the world, this instrument is supplied with one of the power cables shown in Figure 2-7. The cable supplied for use in the United States meets the specifications established by the International Electrotechnical Commission (lEC). The male connector of this cable is a NEMA type and the female connector is a C.E.E. type.

2-12. Connect the power cable to a power source receptacle that has a grounded third conductor. If the line power receptacle is a two-pin type instead of a three-pin receptacle, use a two- to three-pin adapter (HP Part No. 1251-0048 for USA applications) and connect the green lead on the adapter to earth ground. See warning above. If counter is to be operated with 230V ac line power, an Underwriters Laboratories listed connector should be used to connect power.

2-13. Operating Environment

2-14. Maximum and minimum allowable operating temperatures are listed in Table 1-3. If these limits are exceeded at the installation site, auxiliary cooling or heating should be used to keep the environment within limits. A l-inch space above the counter should be clear to allow cooling air circulation. The cooling fan exhaust port at rear is to be kept clear.

2-15. Bench Operation

2-16. The instrument cabinet has plastic feet and the large tilt carrying handle will fold under for convenient bench operation. The tilt handle permits inclining the instrument for ease in using front-panel controls and indicators.

NOTE

The tilt carrying handle may be secured in any position by tightening the knurled side screws.

2-17. Rack Mounting

2-18. The counter is ready for bench operation as shipped from the factory. To mount the counter in a rack, it is necessary to order and install the rack flange kit listed in Table 7-2.

CAUTION

Ambient temperature in rack during operation should not exceed 112°F (50°C). Be sure instrument position in rack permits adequate air circulation and that nearby equipment does not discharge hot air directly on the instrument.

2-19. PACKAGING FOR RESHIPMENT

2-20. Original Packaging

2-21. The same containers and materials used in factory packaging can be obtained through the Hewlett-Packard Sales and Service Offices listed at the rear of this manual.

2-22. If the counter is being returned to Hewlett-Packard for service, attach a tag indicating the type of service required, return address, model number, and full serial number. Mark the container FRAGILE to assure careful handling.

2-23. In any correspondence refer to the counter by model number and full serial number.

2-24. Other Packaging Methods

2-25. If factory packaging is not available, good commercial packing should be used. Contract packaging companies in many cities can provide dependable custom packaging on short notice. The following general instructions should be followed when repackaging with commercially available materials.

a. If shipping to a Hewlett-Packard Service Office or Service Center, attach a tag indicating the type of service required, return address, model number, and full serial number.

b. Wrap the counter in heavy paper or plastic.

c. Use a strong shipping container. A double-wall carton made of 350-pound test material is normally adequate for shipments inside the U.S.

d. Use enough shock-absorbing material (3-to 4-inch layer) around all sides of the counter to provide a firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

e. Seal the shipping container securely.

2-26. STORAGE

2-27. If the counter is to be stored for an extended period of time, it should be enclosed in a clean, dry, sealed container. See specifications in Section I for storage environmental limitations.

SECTION III
OPERATION
(OPERATORS INSTRUCTIONS)

3-1. INTRODUCTION

3-2. This section contains information necessary to understand how to control and use the counter. Specific details and examples are provided for making measurements of frequency, period, period average, time interval and time interval average, and ratio. How to use the external frequency standard input is described. Programming information for use with the HP-IB Interface and the Programmable Input Module is provided. Front and rear panel controls, connectors, and indicators are described.

3-3. FREQUENCY MEASUREMENTS

3-4. To make a frequency measurement on a CW signal below 100 MHz, select FREQ A function, select the appropriate input signal conditioning, and apply the signal to A input. The RESOLUTION switch determines the resolution of the measurement. Since the 5328A is a conventional counter, 1 Hz resolution is obtained in 1-second of measurement time (e.g., .1Hz 10 seconds). The .1 Hz best case frequency resolution limits the low frequency measurement accuracy. In practice, low frequencies are measured by making a period or period average measurement and inverting the result to obtain frequency.

3-5. To make a frequency measurement on a CW signal in the range of 30 to 500 MHz, select FREQ C function and apply the signal to the Channel C input. Make sure that the amplitude does not exceed 5V rms. The trigger level for the Channel C is fixed at 0V dc. If pulse waveforms are being measured, they must cross through 0 volts dc by at least 25 mV. Pulse widths down to 1 ns can be counted.

CAUTION

DO NOT exceed 5 volts rms at “C” channel input. Circuits in this channel may be damaged by higher voltages.

3-6. The A, B, and C input modules are direct count modules. Direct count allows greater resolution per-second of measurement time than prescaling techniques and is important in making frequency measurements on pulse bursts since the allowable measurement time is fixed (it must be less than the width of the burst).

3-7. When the 5328A is in FREQ A or FREQ C function and the rear panel ARM switch is OFF, a measurement cycle is initiated (i.e., arms the counter) upon the first trigger level crossing at the A (or C) input. This means that pulsed signals are measured as easily as CW if the measurement time (determined by the RESOLUTION switch) is less than the width of the pulse.

3-8. With the ARM switch ON, FREQ A and FREQ C are armed by a trigger event at the B input. This mode is useful whenever it is desired to have real time control over when a measurement is to begin. Useful applications include measuring frequency variations along a frequency burst and linearity testing of sweep generators. Figure 3-7 illustrates the setup for measuring the linearity of a sweep generator. The Channel B Trigger level is adjusted to trigger (and thereby arm the counter) at various points along the sweep out waveform. By plotting the B trigger levels and the corresponding frequency measurements made at those levels, the linearity of the generator may be determined.

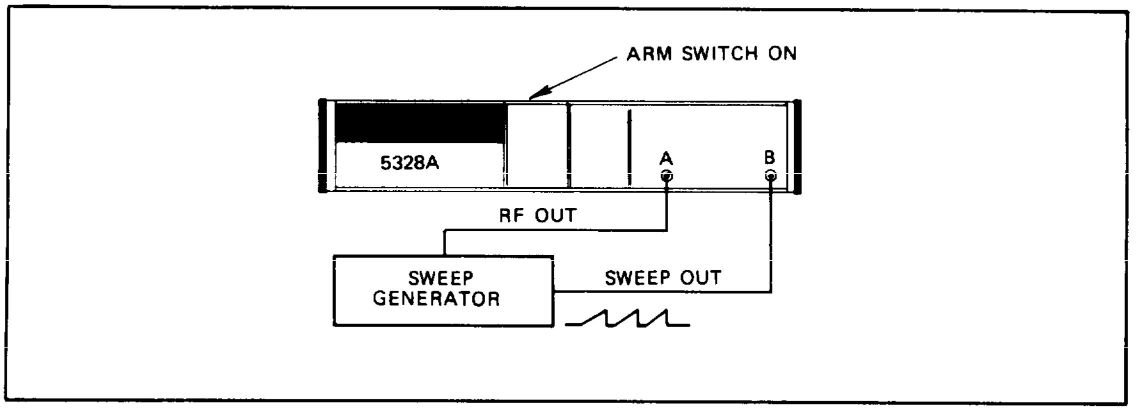


Figure 3-1. Measuring Linearity

3-9. PERIOD MEASUREMENTS

3-10. The PERIOD and PERIOD AVG functions allow single period measurement or multiple period averages to be made on input signals into Channel A for frequencies up to 10 MHz. These modes are useful for making low frequency measurements where maximum resolution is desired.

3-11. To make a PERIOD or PERIOD AVG measurement, select the desired function, select appropriate input signal conditioning, and apply the signal to the A input. For single period measurements, the RESOLUTION switch scales the time base frequency which determines the resolution of the measurement. For optimum resolution, select N=1. Other N values may be desirable to prevent display overflow or to get rid of unstable digits. For PERIOD AVG measurements, the RESOLUTION switch selects the number of periods over which the period average measurement is made (the time base is 10 MHz for this case). the PERIOD AVG mode gives increased resolution and accuracy. Trigger error is decreased by N and the resolution is increased by N (resolution = $\frac{100\ ns}{N}$. The measurement time is equal to the period times N.

3-12. In PERIOD and PERIOD AVG with the rear panel ARM switch OFF, the measurement cycle is initiated by the SAMPLE RATE control and the input signal. With the ARM switch ON, PERIOD and PERIOD AVG are armed by a trigger event at the B input. To measure the frequency of a tone burst signal, use arming and the PERIOD AVG (for increased resolution over a low frequency measurement) as shown in *Figure 3-2.* Select N equal to or less than the number of periods in the tone burst and adjust Channel B trigger level to trigger on the first cycle of the input signal.

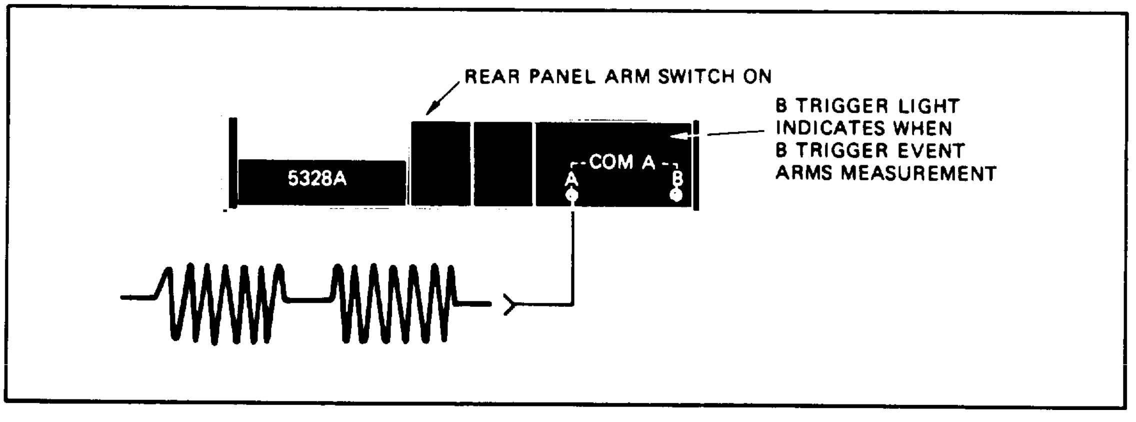


Figure 3-2. Tone Burst Measurement

3-13. TIME INTERVAL MEASUREMENTS

3-14. One of two time interval functions can be selected, time interval or time interval average. These functions measure the time interval between a START signal at the Channel A input and STOP signal at the Channel B input. If both the START and the STOP signals are derived from the same signal, place the COM A-SEP in COM A position. Separate slope and level controls for each channel allow variable triggering on either positive or negative going slope.

3–15. In single-shot time interval measurements, Channel A opens the main gate and Channel B closes the main gate. While the main gate is open, 10 MHz is divided by the setting of the RESOLUTION switch and totalized by the counter. For optimum resolution, select N=1. Other N values may be chosen to prevent display overflow (e.g., long time intervals) or to get rid of unstable digits. In time interval average measurements, the main gate is open for the number of time intervals selected by the RESOLUTION switch. The 5328A 10 MHz clock is totalized only during the individual time intervals. The resolution of the measurement is improved by the $\sqrt{N}$.

3-16. In order to allow the synchronizers time to reset during time interval averaging, there must be at least 40 ns deadtime (and the additional constraint that the repetition rate be less than 10 MHz). Deadtime is the time between the preceding time interval stop event and the current time interval start event as shown in *Figure 3-3.*

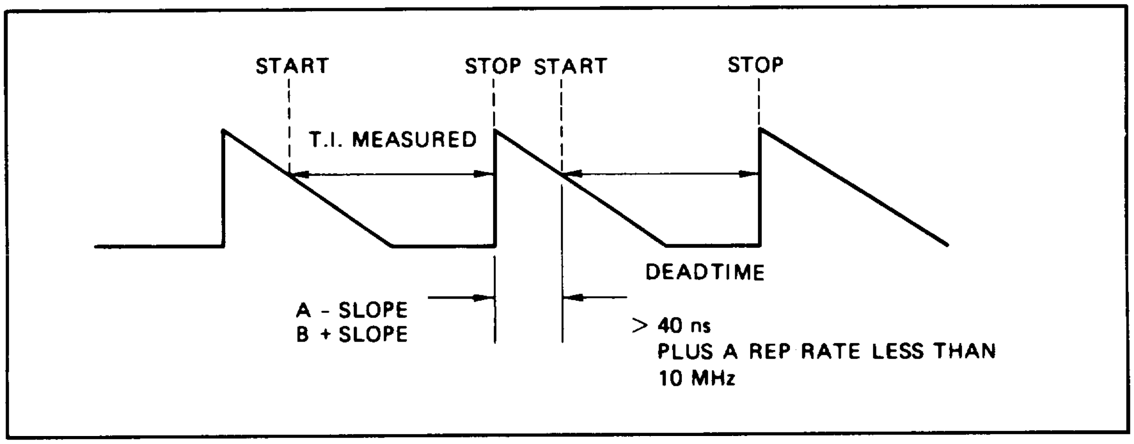


Figure 3-3. Deadtime

3-17. During a time interval average, there must be only one stop pulse for each start pulse. Extraneous stop pulses which occur before the next start pulse are accumulated and give erroneous readings. For example, the case illustrated in Figure 3-4 would result in a reading equal to one-half of the desired time interval.

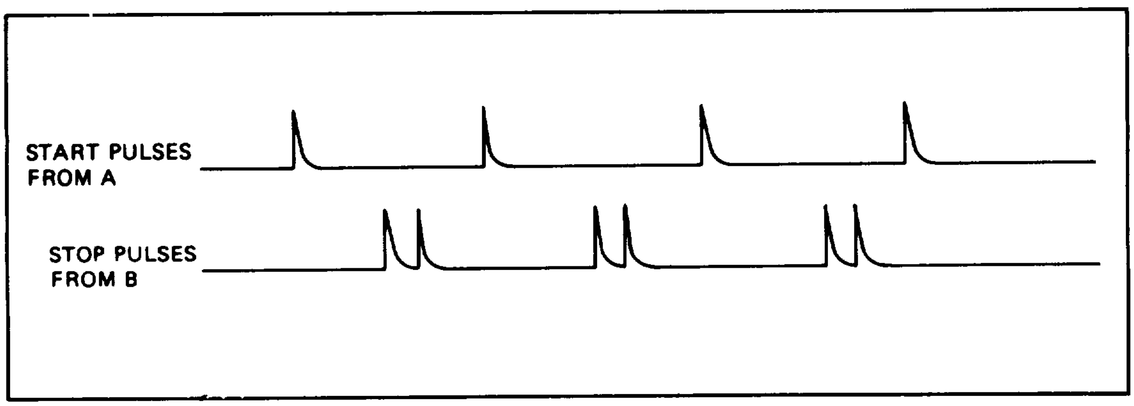


Figure 3-4. Multiple STOP Pukes

3–18. To set up a time interval measurement, the marker outputs may be monitored on an oscilloscope (see Figure 3-5) to indicate where the channels are triggering with relation to the time interval of interest. The GATE/MARKER OUT is high during the time interval being measured.

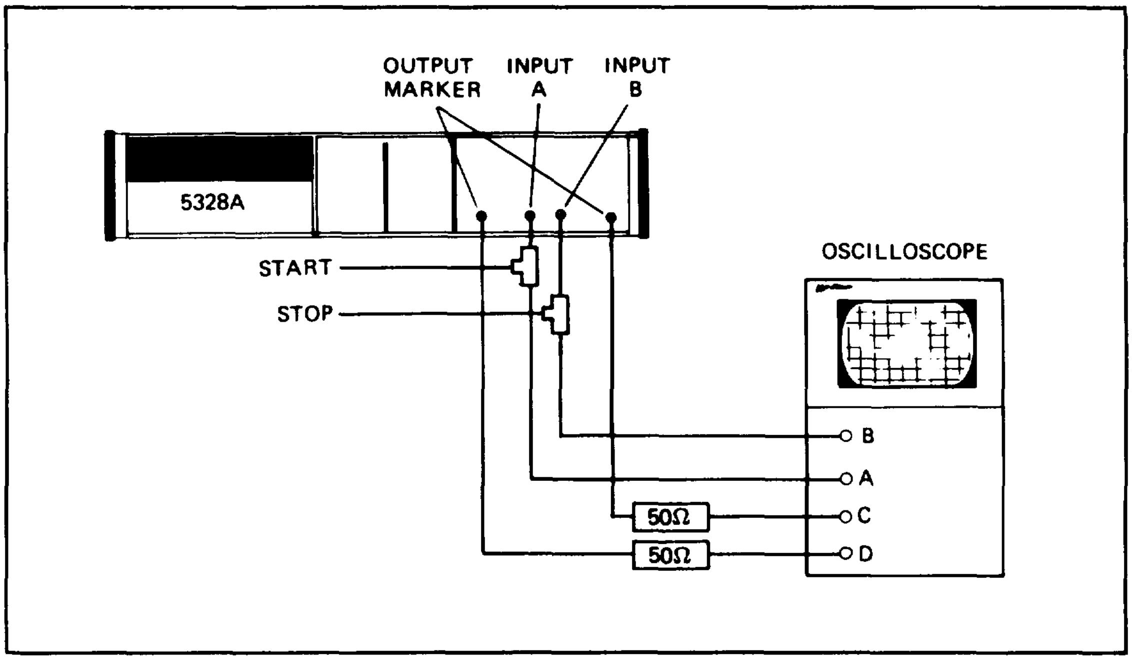


Figure 3-5. Monitoring Marker Outputs

3–19. In T.I. A→B and T.I. AVG A→B with the rear panel ARM switch OFF, the counter is armed by the run down of the SAMPLE RATE control. With the rear panel ARM switch ON, T.I. A→B and T.I. AVG A→B are armed by an event at the C input. For T.I. AVG A→B, only one arming signal is required per average measurement (i.e., the counter doesn't need to be armed prior to each individual time interval in the time interval measurement).

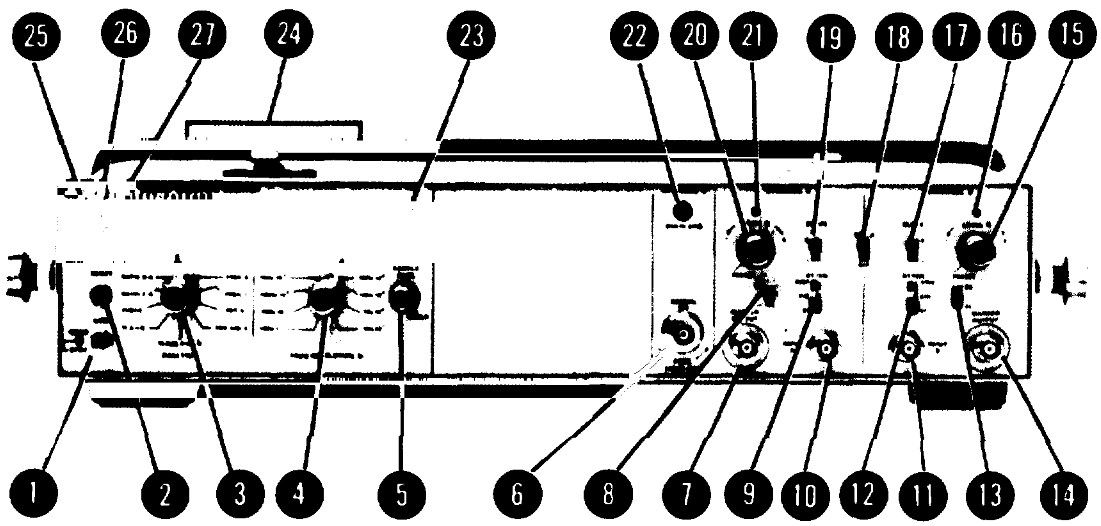
3-20. RATIO MEASUREMENTS

3-21. For ratio measurements, the 5328A has wide bandwidth, good sensitivity, and complete signal conditioning of the Channel A, B, and C input amplifiers.

3–22. Two ratio functions are available: B/A and C/A. The ratio of the frequency at B (or C) to the frequency at A is measured for N counts of A where N is selected by the RESOLUTION switch. The resolution of the measurement improves with increasing N and is given by 1 part in B/A x N (or C/A x N). Since the range of A is 0-10 MHz while B is 0-100 MHz, the lower frequency is normally applied to the A input although there is no restriction that this be the case (i.e., ratios less than 1 may be measured). If B/A is greater than 1, the measurement resolution is better than switching the inputs for a ratio <1, provided the value of N remains the same.

3-23. OPERATING CONTROLS

3–24. All of the front and rear panel operating controls are shown and described in Figures 3-6 and 3-7.



1. LINE switch ❶. In STBY position with light on, supplies power to oven of the high stability time base to maintain a constant temperature for the crystal. In OPER position, supplies normal operating power to the instrument.
2. RESET button ❷. Resets display and internal count to zero. When continuously depressed, lights all segments of the LED display and all annunciator LED's for LED test. Returns 5328A to LOCAL CONTROL when HP-IB Interface is in use.
3. FUNCTION selector ❸. Selects mode of operation.
   a. FREQ A. Sets counter to measure frequency at Channel A.
   b. FREQ C. Sets counter to measure the frequency of the signal at the Channel C input.
   c. PER A. Sets counter to measure period at Channel A.
   d. PER AVG A. Sets counter to make a period average measurement of the signal at Channel A. The number of periods over which the average measurement is made is determined by N, selected by the RESOLUTION switch.
   e. T.I. AVG A→B. Sets counter to make a time interval average measurement of the time interval from A to B. The number of time intervals over which the average measurement is made is determined by N, selected by the RESOLUTION switch.
   f. T.I. A→B. Sets counter to make a time interval measurement. Start signal is applied to Channel A and the stop signal is applied to Channel B.
   g. CHECK. Applies 10 MHz to decade counting assemblies. Verifies operation of SAMPLE RATE control, RESOLUTION switch, and RESET.
   h. RATIO C/A. Sets counter to measure the ratio of the signal frequency at Channel C to the signal frequency at Channel A.
   i. RATIO B/A. Sets counter to measure the ratio of the frequency at Channel B to the frequency at Channel A.
   j. Top blank position has no function.

Figure 3-6. 5328A Front Panel Operation Summary

4. FREQ RESOLUTION, N selection switch (4). Selects resolution in frequency measurements and N for totalizing and averaging measurements. Determines how long the main gate is open for frequency measurements:

N	GATE TIME (Seconds)	RESOLUTION (Hz)
1	1×10^{-6}	1 M
10	10×10^{-6}	100 k
10^2	100×10^{-6}	10 k
10^3	1×10^{-3}	1 k
10^4	.01	100
10^5	.1	10
10^6	1	1
10^7	10	.1

5. SAMPLE RATE control (5). Varies time between measurements continuously from approximately 2 milliseconds to HOLD (which holds display indefinitely).

6. 500 MHz, 50Ω (6), Channel C input BNC connector. Input for "FREQ C" chnnel. Refer to specification in Section I.

7. OUTPUT MARKERS (7),(14). Channel A and B Schmitt trigger outputs indicate when a channel is triggered; 0 to 300 mV levels into 50Ω with less than 20 ns delay.

8. Coupling switch AC-DC (8),(13). Selects ac or dc coupling for input signal. When input amplifier control switch (18) is in COM A, Channel B coupling is determined by setting of Channel A coupling switch.

9. ATTEN switches (9),(12). Selects attenuation of input signal. Signal amplitude is reduced by 10 in X10 and by 100 in X100. When input amplifier control switch (18) is in COM A, Channel B attenuation is determined by setting of Channel A attenuation switch (9).

10. Channel inputs (10),(11). Input channels A and B. (*Table 1-2* lists the type of coaxial cable used with these inputs.)

11. COM A/SEP input amplifier control switch (18). Selects independent operation of Channels A and B in SEP (separate) position. In COM A (Common A) position, the signal at A is also applied to Channel B. (The B input is disconnected from the input circuitry; Channel B coupling and attenuation are determined by the Channel A settings.)

12. Trigger lights (16),(21). Light blinks when its channel is triggering. Light is OFF when input signal is below the trigger level. Light is ON when input signal is above trigger level.

13. LEVEL A/B controls (15),(20). Used in conjunction with ATTEN switch to select voltage at which triggering occurs. With X1 attenuator, level is variable ±2.5 volts. In X10, ±25 volts. In X100, ±250 volts.

14. SLOPE switches (17),(19). Select triggering on either positive or negative slope of input signal.

15. OVERLOAD annunciator (22) indicates (flashes on-off) if more than 5 volts is applied to Channel C input connector (6).

16. OVFL (overflow) annunciator (25). Indicates that one or more of the most-significant digits (digits left-most from the decimal point) are not displayed.

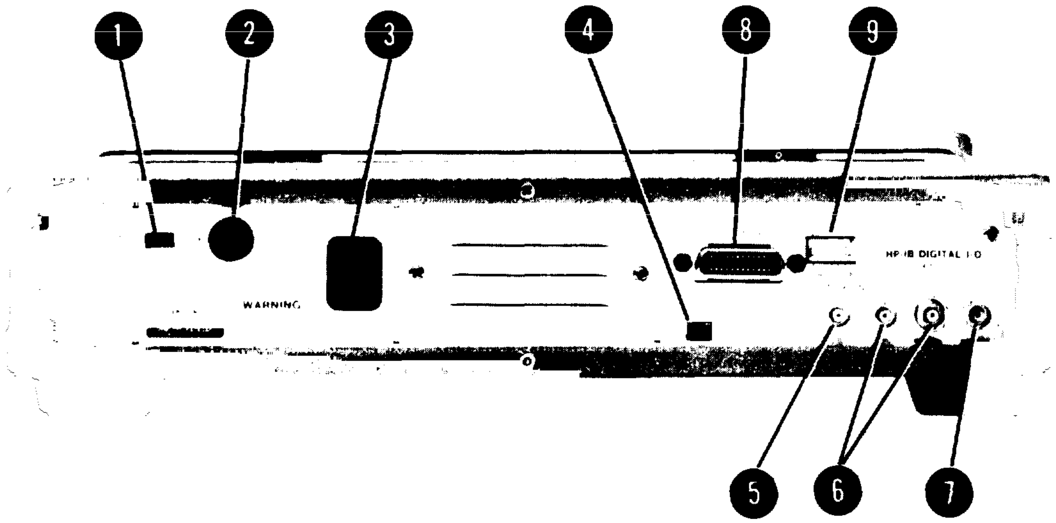
17. RMT (remote) annunciator (26). For counters with HP-IB only. Lights when 5328A is in remote operation.

18. GATE annunciator (27). Indicates when the counter's main gate is open and a measurement is in progress.

19. K,S,M,μ,n, and Hz annunciators (23). Indicates the units multiplier of the measurement.

20. Nine-digit LED display (24) shows all measurements.

Figure 3-6. 5328A Front Panel Operation Summary (Continued)



1 VOLTAGE SELECTOR switch. Selects 115 or 230 volt operation.

2 LINE FUSE. Requires a 2.0 amp fuse for 115-volt operation or a 1.0 amp fuse for 230-volt operation.

3 AC Line connector. IEC type with offset pin connected to chassis.

4 ARM switch. With switch in OFF, counter is armed by the same signal which is involved in the measurement (e.g., FREQ A measurements are armed by the signal at Channel A). With arming ON, the measurement is armed by an input other than the input involved in the measurement. The following are armed by an event at B: FREQ A, PERIOD A, PERIOD AVG A, FREQ C, C/A; the following are armed by an event at C: T.I. A→B, T.I. AVG A→B, RATIO B/A.

5 EXT OSC INput connector allows separate outside signal to be used for time base.

6 1 MHz OUT and 10 MHz OUT connectors allow internal high stability oscillator signal to be used outside the 5328A. Outputs are buffered.

7 GATE/MARKER OUT connector. High when the main gate is open.

8 HP-IB Interface connector (24-pin). Used to convey data and programming instructions.

9 HP-IB Interface address switch. See Programming Operation in this Section.

Figure 3-7. 5328A Rear Panel Controls and Connectors

3-25. FUNCTION OF CONTROLS, INDICATORS, INPUTS, AND OUTPUTS

3-26. The following paragraphs provide a detailed description of the function of controls, indicators, and connectors.

3-27. Display

3-28. The 5328A counter display consists of nine-digit, seven-segment LED display and annunciators for indicating the measurement units of Hz, s, as well as multiplier indicators (K, m, μ, n). These display units and multipliers are automatically displayed along with the correct decimal point location. Overflow (OVFL) indicates that left-most-significant digits have overflowed the display. Remote (RMT) indicates that the counter (HP-IB interface) is under remote program control. A GATE lamp indicates that the counter has been armed and that a measurement is in process.

3-29. Power (Line)

3-30. The LINE switch puts the counter in OPER (operate) or STBY (standby). The STBY position with STBY light on turns off some but not all the power supply voltages. This circuit arrangement allows the high stability oscillator to operate continuously. Therfore, the input to main power transformer (T1) plus the unregulated dc voltage to the oscillator oven is always energized whenever power is connected even with the line switch in STBY.

3-31. Reset

3–32. The RESET pushbutton resets the display and internal count to zero and also initiates single measurements when the SAMPLE RATE control is in the HOLD mode, The HP-IB interface, provides remote control capability, pushing the RESET button restores the counter to local control (when not remotely locked out by the HP-IB Local Lockout universal command). Refer to programming in this section.

3-33. Sample Rate Control

3–34. The SAMPLE RATE control sets the minimum time between samples, The time is continuously variable from less than 2 milliseconds between measurements to HOLD, which holds the display indefinitely.

NOTE

The counter will internally (self) arm (via the SAMPLE RATE control) only when ARMing is OFF and the FUNCTION selected is at other than FREQ A, FREQ C, and RATlO C/A.

3-35. Arming

3-36. The counter may be armed internally (i.e., made ready to start a measurement) by the SAMPLE RATE control, or externally by the input signal itself, (arming off) or by a signal not directly involved in the measurement (arming on). Table 3-7 is an arming status table. A rear panel switch turns ARMing either ON or OFF. The counter is armed within 1 μs after the event at the B arming input and is armed within 10 μs after the event of the C arming input.

Table 3-1. Arming Status

FUNCTION	ARMING OFF	ARMING ON
FREQ A	Armed by A input	Armed by B input
PERIOD A	Armed by SAMPLE RATE	Armed by B input
PERIOD AVG A	Armed by SAMPLE RATE	Armed by B input
T.I. A to B	Armed by SAMPLE RATE	Armed by C input
T.I. AVG A to B	Armed by SAMPLE RATE	Armed by C input
FREQ C	Armed by C input	Armed by B input
RATIO B/A	Armed by SAMPLE RATE	Armed by C input
RATIO C/A	Armed by C input	Armed by B input

3-37. Frequency Resolution, N Switch

3-38. The FREQUENCY RESOLUTION, N switch determines the amount of time that the counter's main gate is open for a particular measurement when the Main Gate FF (refer to Section IV) determines the gate time. Depending on the measurement, this time results in a certain measurement resolution (e.g., frequency measurements), a number of intervals averaged (e.g., T.1. AVG measurements), or a scaling factor by which the time base is divided (e. g., period measurements). Table 3-2 shows the setting of the RESOLUTION switch and the corresponding time the main gate is open.

Table 3-2. Frequency Resolution, N Switch Settings and Gate Times

RESOLUTION	N	GATE TIME
1 Hz	10^7	10 s
1 Hz	10^6	1 s
10 Hz	10^5	.1 s
100 Hz	10^4	10 ms
1 kHz	10^3	1 ms
10 kHz	10^2	100 μs
100 kHz	10	10 μs
1 MHz	1	1 μs

3-39. Table 3-3 summarizes the FUNCTIONS and the corresponding interpretation of the FREQUENCY RESOLUTION, N switch setting.

Table 3-3. Functions and Resolution Switch Settings

FUNCTION	RESOLUTION, N SWITCH
FREQ A, FREQ C	Indicates frequency resolution in Hz.
PERIOD A, T.I. A to B	Indicates the factor (N) by which time base is scaled. Maximum resolution occurs with N=1.
PERIOD AVG A, T.I. AVG A to B	Indicates number of time intervals or periods over which the average measurement is made.
RATIO B/A, RATIO C/A	Indicates the number of counts at the A input over which the ratio measurement is made. Resolution improves with increasing N.

3-40. Input Channel Section

3-41. Two separate inputs are provided on the right side of the panel. The A and B inputs are identical in specification and identical controls are provided for each input to allow maximum versatility and accuracy.

3-42. HP-IB PROGRAMMABLE INPUT CONTROLS. In COM A position, the output of the Channel B attenutor is disconnected. The output of the Channel A attenuator is routed to the A and B input amplifiers as shown in Figure 3-8. In COM A the Channel B AC-DC, X1, X10, X100 Attenuator relays are disabled. The Channel A AC-DC, X1, X10, X100 Attenuator determine the coupling for the Channel B amplifier.

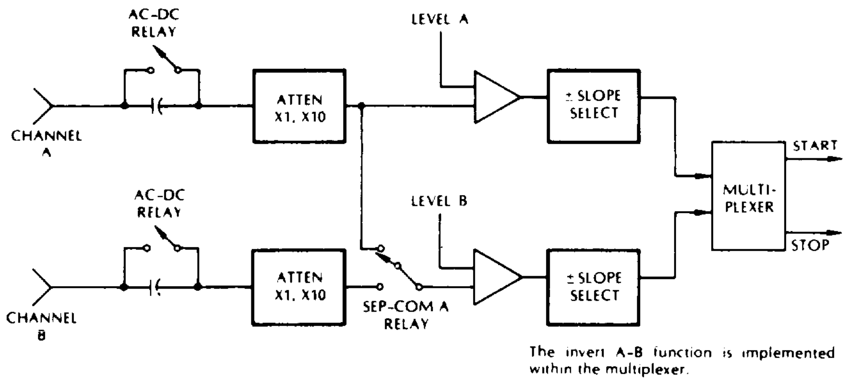


Figure 3-8. Programmable Input Switch Configuration for COM A

3-43. The A and B input amplifiers have independent LEVEL and SLOPE controls regardless of the mode of operation (SEP or COM A).

3-44. A and B Channel Signal Conditioning

3-45. AC-DC SWITCH. The AC-DC switch controls the coupling of the external signal to the attenuator-amplifier by switching a capacitor in series in the AC position or by direct coupling in the DC position. The advantage of AC coupling is to provide a DC block for signals with a DC component. DC has the disadvantage of being unable to pass low frequency signals. A distinct advantage of having DC coupling cover the full bandwidth (DC-100 MHz) is that extremely accurate time interval or pulse measurements can be achieved even though pulse widths or repetition rates vary since the trigger point is independent of the duty cycle of the input signal.

3-46. ATTENUATOR. The attenuator (ATTEN) connects the input signal directly to the amplifier (in X1) or through a 10:1 attenuator (X10) or a 100:1 attenuator (X100) to increase the voltage range by 10 or 100 times to allow measurement of high level signals that would otherwise be impossible without external attenuation.

3-47. SLOPE SWITCH. The ±SLOPE switch (provided for each channel) determines which slope of the input signal will trigger the counter. As a simple example, (Figure 3-9) if the pulse width of a positive pulse is to be measured, the A channel slope switch would be set to "+" and the B channel would be set to "-" (for time interval measurements the A channel always begins the measurement and the B channel ends the measurement).

NOTE

A simple pulse width measurement is achieved with the use of the +SLOPE setting for Channel A and the -SLOPE setting for Channel B.

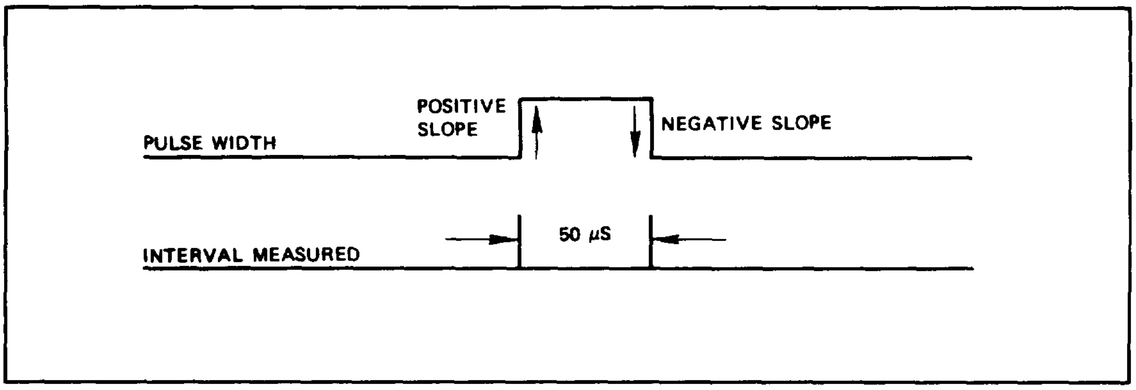


Figure 3–9. Slope Switch Settings

3-48. LEVEL CONTROL. The LEVEL control for each channel is adjustable over the range of ±2.5V dc with the attenuator for that channel in the X1 position. A typical use of the LEVEL controls is shown in Figure 3-10.

NOTE

Simple measurement of a time interval, the LEVEL control of the A and B input channels were used to set the trigger LEVEL of A and B.

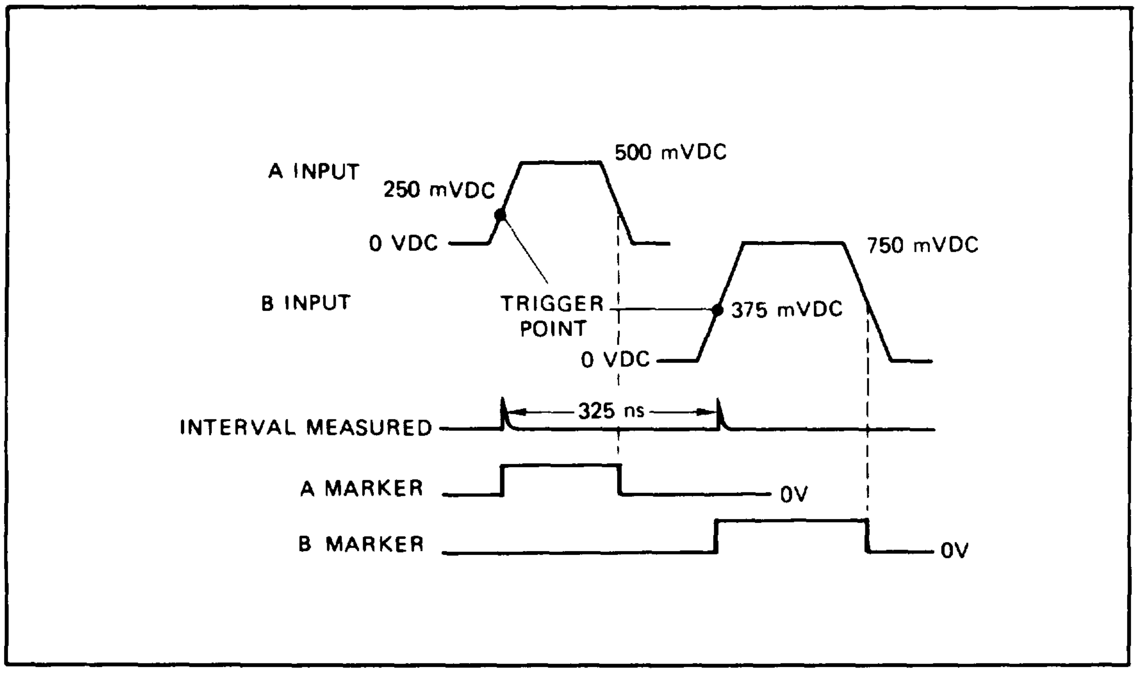


Figure 3-10. Level Control Settings

3-49. Channel C Input

3-50. The CHANNEL C 500 MHz 50Ω input is useful for higher frequency signals out of the A and B input channel range (0 to 100 MHz).

CAUTION

The "C" channel input signal should be limited to 5 volts maximum. If this limit is exceeded the inline fuse may open (blow).

3-51. "C" Channel Overload Indicator

3-52. The OVERLOAD (CHANNEL C) indicator will flash on and off if the voltage maximum is exceeded at the "C" channel input.

3-53. Hysteresis Band of Trigger Levels

3-54. The width of the trigger level hysteresis band, shown in Figure 3-77 is determined by the sensitivity of the counter. For frequencies below 40 MHz, it is typically less than 25 mV peak-to-peak. At frequencies from 40 MHz to 100 MHz, it is typically less than 70 MHz peak-to-peak. The signal must pass through the entire hysteresis band before a trigger pulse is generated. If the SLOPE switch is set to "+", the trigger pulse occurs at the top of the hysteresis band. If the SLOPE switch is set to "-", the trigger pulse "occurs at the bottom" of the hysteresis band.

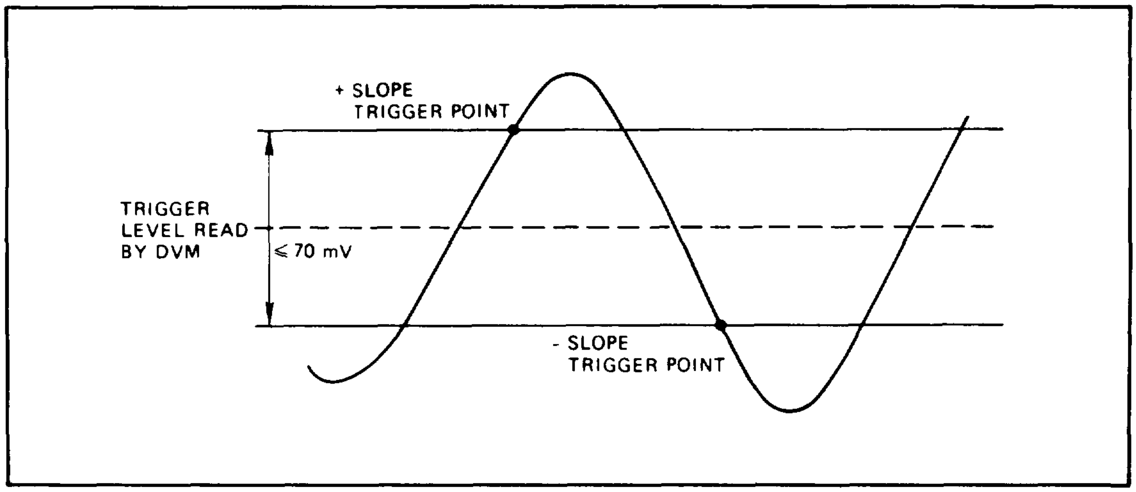


Figure 3–11 Hysteresis Band

3-55. Since trigger level measurements indicate the center of the hysteresis band, a better value for the actual trigger level may be obtained by subtracting one-half the hysteresis band ("-" slope) or adding one-half the hysteresis band ("+" slope). A typical value for the width of the hysteresis band is 30 mv peak-to-peak.

3-56 The value to use for the hysteresis band depends on the frequency; or, for pulses, it depends on the rise time.

3-57. External Frequency Standard Input

3-58. The rear panel external frequency standard (EXT OSC IN) input is useful for locking the counter to a high stability external frequency standard. This external standard must be 1, 2.5,5, or 10 MHz, with an amplitude of >1V rms into 1 kΩ (maximum input of 5 volts peak-to-peak).

3-59. Marker Outputs

3-60. Two marker output connectors are mounted on the front panel. These outputs represent the Channel A and Channel B Schmitt triggers. The outputs provide 0 to 300 mV levels into 50Ω delayed by less than 20 ns. These outputs are useful for oscilloscope monitoring, Time interval measurement setups are simplified if the time interval of interest and the marker outputs can be simultaneously displayed on oscilloscope traces. Frequency measurements on noisy signals can be made with more confidence since the markers can indicate the presence of noise triggering. These outputs are protected from inadvertently applied voltage to ±5V dc.

3-61. Gate/Maker Out

3-62. the GATE/MARKER OUT rear panel connector supplies a TTL level which is high when the counter's main gate is open and low when it is closed. Monitoring the GATE OUT on an oscilloscope can provide this information for applications where the markers do not give the desired information.

3-63. 1 MHz and 10 MHz Frequency Standard Outputs

3-64. The 1 MHz OUT and 10 MHz OUT connectors are on the rear panel. When terminated in 50 ohms, the output is a square wave of approximately l-volt amplitude.

3-65. Trigger Lights

3-66. A trigger light is provided for each (A and B) input channel to enable the user to know not only if the channel is triggering, but also in which direction the trigger level must be adjusted to cause triggering. The light is ON when input is above the trigger level; OFF when input is below the trigger level; BLINKING when channel is triggering. The trigger lights are operative over the full frequency range of dc to 100 MHz.

3-67. The trigger lights can be used with a 10:1 oscilloscope probe to provide a logic probe function. By adjusting the trigger level to one-tenth (since using 10:1 divider probes) of the threshold voltage for the logic family under investigation (e.g., .14 volts for TTL), the light indicates the logic state of circuit points which are contacted with the probe. When the trigger level light is ON, the circuit node is a high (i.e., above the threshold voltage). If the light is OFF, the node is a logical low. If the light blinks, then pulses (up to 100 MHz rep rate) are present at the node. The trigger lights can also detect the polarity of low rep rate pulses down to 5 ns pulse width. Positive pulses cause the light to blink on while negative pulses cause the light to blink off.

3-68. PROGRAMMING OPERATION

3-69. The 5328AF/096/H42 Universal Counter is fully compatible with the Hewlett-Packard Interface Bus (HP-1B) IEEE Standard 488-1975 Appendix C.

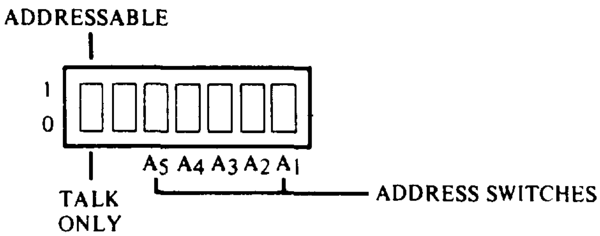
3–70. Procedures for verification of proper operation of the 5328AF/096/H42 in the remote mode are contained in paragraphs 5–37 through 5-42.

3-71. SETTING ADDRESS SWITCHES

3-72 To use the 5328A in an HP-IB based system the first step is to set the rear panel address switches shown in Table 3-4. The left-most switch sets the counter to ADDRESSABLE or TALK ONLY mode. ADDRESSABLE mode is used whenever a calculator or other controller is used within the system. TALK ONLY mode is used when the counter will be controlled manually but will output results to another device on the bus such as a printer or D/A converter.

3-73. The five right-hand switches, AS through A1, set the talk and listen addresses to the 5328A when it is used in the ADDRESSABLE mode. Table 3-4 shows the possible address settings and the corresponding ASCII codes for talk and listen addresses.

Table 3-4. Addresssing



ASCII ADDRESS CODES

A_5	A_4	A_3	A_2	A_1	ASCII LISTEN ADDRESS	ASCII TALK ADDRESS
0	0	0	0	0	SP	@
0	0	0	0	1	!	A
0	0	0	1	0	"	B
0	0	0	1	1	#	C
0	0	1	0	0	$	D
0	0	1	0	1	%	E
0	0	1	1	0	&	F
0	0	1	1	1	'	G
0	1	0	0	0	(	H
0	1	0	0	1	)	I
0	1	0	1	0	*	J
0	1	0	1	1	+	K
0	1	1	0	0	,	L
0	1	1	0	1	-	M
0	1	1	1	0	.	N
0	1	1	1	1	/	O
1	0	0	0	0	Ø	P
1	0	0	0	1	1	Q
1	0	0	1	0	2	R
1	0	0	1	1	3	S
1	0	1	0	0	4	T
1	0	1	0	1	5	U
1	0	1	1	0	6	V
1	0	1	1	1	7	W
1	1	0	0	0	8	X
1	1	0	0	1	9	Y
1	1	0	1	0	:	Z
1	1	0	1	1	;	[
1	1	1	0	0	<	\
1	1	1	0	1	=	]
1	1	1	1	0	>	^

3–74. Table 3–5 gives the program code set for the 5328AF/096\H42. All Function, Frequency Resolution, N and Channel A/B Signal Conditioning are analogous to the corresponding front-panel operations described previously.

Table 3-5. Program Code Set

Codes shown in **bold face** are start-up conditions. These conditions are set by the code "P", Remote Program Initialize, or by the bus commands Device Clear or Selected Device Clear.

1. Initialization
   - P Remote Program Initialize
2. Function
   - F4 Freq. A
   - F6 Period A
   - F7 Per. Avg. A
   - F8 T.I. A→B
   - F9 B/A
   - F: T.I. Avg. A→B
   - F< Check
   - F= C/A
   - F> Freq. C
3. Time Base

Code	Freq Res	Multiplier	Time Res (Std)
G∅	**1 MHz**	**1**	**100 ns**
G1	100 kHz	10	1 μs
G2	10 kHz	10^2	10 μs
G3	1 kHz	10^3	100 μs
G4	100 Hz	10^4	1 ms
G5	10 Hz	10^5	10 ms
G6	1 Hz	10^6	100 ms
G7	0.1 Hz	10^7	1 s

4. Single-Multiple Measurement
   - **S∅ Single Measurement**
   - S1 Multiple Measurement
5. Measurement Cycle
   - **S2 Wait to output; Service Request at end of measurement**
   - S3 Continue cycle; no Service Request
6. Output Mode
   - **S4 Output at end of measurement**
   - S5 Output when addressed (on-the-fly)
7. Sample Rate
   - **S6 Maximum**
   - S7 Manual control (fron front panel)
8. Arming
   - **S: Off**
   - S; On
9. Display Storage
   - **S< On (normal)**
   - S= Off
10. Decade Reset
    - **S> Normal**
    - S? Disabled (for cumulative measurements)
11. Display Blanking
    - **U Normal display**
    - Q Blank display (digits and decimal point)
12. Channel A Signal Conditioning
    - a. Coupling
      - **A2 AC**
      - A3 AC
    - b. Slope
      - **A4 +slope**
      - A5 -slope
    - c. Attenuator
      - A1 X100
      - **A6 X10**
      - A7 X1
13. Separate - Common
    - **A8 Separate**
    - A9 Common A
14. Trigger level A
    - volts
    - tenths of volts
    - hundredths of volts

$A \pm d_1\, d_2\, d_3$ •

Permissiable trigger level range: -2.50V to +2.50V.

The program sequence to set trigger level starts with the channel designation letter followed by a "+" or "–" sign. Next, three digits set the voltage level. An "•" terminates the sequence. The same sequence must be used even to set 0 volts.

Examples: "A+000•" 0 volts
"A–123•" -1.23 volts

15. Channel B Signal Conditioning
    - a. Coupling
      - **B2 AC**
      - B3 DC
    - b. Slope
      - **B4 +slope**
      - B5 -slope
    - c. Attenuator
      - B1 X100
      - **B6 X10**
      - B7 X1
16. Trigger Level B
    - $B \pm d_1\, d_2\, d_3$ •
    - See Group 15, Trigger Level A, for details.
17. Channel Invert
    - **B8 Normal**
    - B9 Invert A and B inputs
18. Reset; Trigger
    - (Also see Bus Command GET)
    - **R Reset, no trigger**
    - T Reset and trigger

3-75. MEASUREMENT OUTPUT FORMAT

3-76. The 5328AF/096/H42 transmits the following string of characters to output a measurement:

Position	1	2	3 thru 12	13	14	15	16	17
Character	{O / SP}	{+ / -}	{9 digits and decimal point .}	E	{+ / -}	d	CR	LF

"O" in the first position indicates measurement overflow. Leading Ø's in positions 3 to 12 are output as SP (space) if they occur to the left of the decimal point except for the Ø next to the decimal point. The decimal point may appear at positions 4 to 12. The output string is always 17 characters long. Typical character output strings are:

1	2	3	4	5	6	7	7	9	10	11	12	13	14	15	16	17
SP	+	5	Ø	3	.	2	1	7	6	9	8	E	+	6	CR	LF
SP	+	SP	SP	SP	5	4	3	2	1	Ø	.	E	-	3	CR	LF
0	+	Ø	5	3	1	.	8	5	4	2	Ø	E	+	6	CR	LF

The 5328AF/096/H42 inserts a Ø in position 12 of the output string for all measurements that don't use the ninth digit of the display. This extra Ø fills the output string to a constant 17 characters.

3-77. BUS COMMANDS

3-78. The 5328AF/096/H42 obeys the following HP-1 B Universal Commands and Addressed Commands (ASCII codes shown in parenthesis and in Table 3-6).

a. Universal Commands:

LLO Local Lockout (ASCII DC1)

Disables all programmable front panel controls including reset. Go To Local (GTL) must be programmed to return to manual control.

DCL Device Clear (ASCII DC4)

Resets the programmed state of the counter to the codes shown in bold face in the program code set. Has the same effect as the program code "P".

SPE Serial Poll Enable (ASCII CAN)

Sets the counter to the serial poll mode. When addressed to talk during the serial poll mode, the 5328A produces a status byte to indicate its condition. If the counter has completed a measurement and it requesting service, the status byte contains a "1" in bit 7 (decimal value 64). If the counter has not requested service, the status byte will be "0" in all bits. When addressed to talk in the serial poll mode, the counter will immediately stop requesting service.

SPD Serial Poll Disable (ASCII EM)

Terminates the serial poll mode. The 5328A can resume its normal data output mode.

b. Addressed Commands:

GTL Go To Local (ASCII SOH)

Returns the 5328A to local (manual) control from remote control.

SDC Selected Device Clear (ASCII EOT)

Responds as with Device Clear or program code “P”.

GET Group Execute Trigger (ASCII BS)

Starts a measurement. This command provides the quickest method to start a measurement cycle.

Table 3-6. American Standard Code for Information Interchange (ASCII)

USA STANDARD CODE FOR INFORMATION INTERCHANGE

BITS				b_7 b_6 b_5	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP (blank)	0	@	P	\`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	¦
1	1	0	1	13	CR	GS		=	M	]	m	}
1	1	1	0	14	SO	RS		>	N	↑	n	~
1	1	1	1	15	SI	US	/	?	O	—	o	DEL

UNIVERSAL ADDRESS COMMANDS (columns 0–1)

LISTEN ADDRESSES (columns 2–3) — UNLISTEN COMMAND (?)

TALK ADDRESSES (columns 4–5) — UNTALK COMMAND (—)

DATA WHEN ATN IS HIGH. ADDRESSES WHEN ATN IS LOW.

3-79. PROGRAM EXAMPLES

3-80. The following examples illustrate the programming capability of the 5328AF/096/H42, using the HP9825A Desktop Computer as a computing controller.

3-81. Example 1

3-82. This program sets the 5328AFA/096/H42 into its CHECK mode, with 1 Hz resolution. The program takes a measurement (trg 701) and reads it into the A register of the HP9825A. After waiting 500 ms, the program loops back to line 1 for the next trigger.

```
0: wrt 701,"PF<G
 6R"
1: trg 701;red
 701,A;dsp A;
 prt A
2: wait 500;gto
 1
3: end
*9943
```

```
10000000.00
10000000.00
10000000.00
10000000.00
10000000.00
10000000.00
10000000.00
10000000.00
```

3-83. Example 2

3-84. This program sets the 5328AF/096/H42 into its Frequency mode with 1Hz resolution. The program takes a frequency measurement, reads it into the A register of the HP9825A, and prints the results. The calculator computes the period from the frequency measurement and prints the calculated period. The program then sets the 5328AF/096/H42 into its PERIOD mode with 10 µs resolution. A period measurement is made, read into the C register of the HP9825A and printed. After waiting 2 sec, the program loops back to line 0 for the next trigger.

```
0: wrt 701,"PF4G
 6S13R"
1: red 701,A
2: prt "MEASURED
   FREQ=",A,"
             HZ"
3: 1/A→B;flt 2
4: prt "CALC
  PERIOD=",B,"
              sec"
5: wrt 701,"PF7G
 2S13R"
6: red 701,C
7: prt "MEASURED
   PERIOD=",C,"
               sec"
8: prt "--------
 --------";spc
 2;wait 2000
9: gto 0
10: end
*31082


----------------
```

```
MEASURED FREQ=
         9.73e 05
               HZ
CALC PERIOD=
        1.03e-06
             sec
MEASURED PERIOD=
        1.03e-06
             sec
----------------


MEASURED FREQ=
         9.73e 05
               HZ
CALC PERIOD=
        1.03e-06
             sec
MEASURED PERIOD=
        1.03e-06
             sec
----------------
```

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section contains a description of the operating principles of the counter in reference to an overall block diagram in this section and to individual block and schematic diagrams in Section VIII.

4-3. OVERALL DESCRIPTION

4-4. The 5328A is a 500 MHz universal frequency counter with the following capabilities.

- Frequency — 100 and 500 MHz direct count
- Period — 100 ns resolution
- Period Average — 10 MHz clock
- Time Interval — 100 ns single-shot resolution
- Time Interval Average
- Ratio — 100 MHz/10 MHz
- Check

4-5. BASIC COUNTER OPERATION

4-6. The operation of the frequency counter is best understood by describing how the counter performs a frequency measurement. If n is the number of cycles of a signal that occurs in a time period, t, the average frequency, f, of that signal over the time period, t, is given by

$$f = \frac{n}{t} \qquad (1)$$

4-7. Frequency

4-8. The counter measures the frequency, f, by accumulating the number of cycles, n, of the input signal that occurs over the time period, t. The basic counter elements necessary to perform this measurement are shown in Figure 4-1.

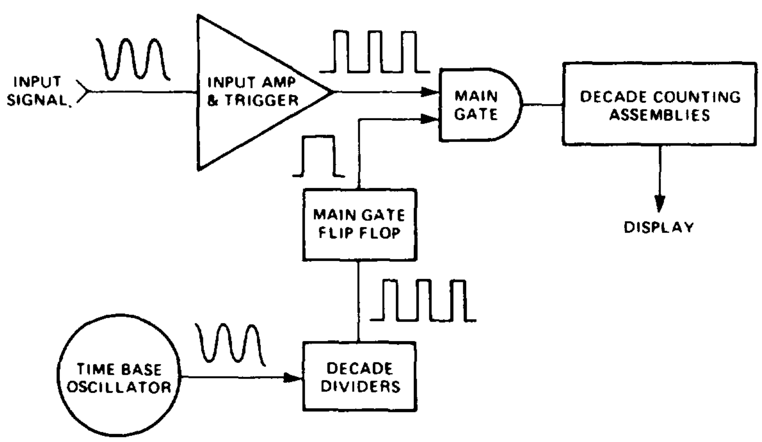


Figure 4-1. Basic Elements of the Frequency Counter

4-9. INPUT AMPLIFIER AND TRIGGER — essentially conditions the input signal to a form that is compatible with the internal circuitry of the counter. As Figure 4-7 indicates, the output of the amplifier/trigger is a pulse train where each pulse corresponds to one cycle or event of the input signal.

4-10. TIME BASE OSCILLATOR — is that element of the counter from which the time, t, of equation (1) is derived. From equation (1) it may be seen that the accuracy with which t is determined has a significant effect on the measurement accuracy of the frequency, f. The 5328A employs a 10 MHz temperature-controlled (oven-regulated) precision, crystal oscillator as the time base element.

4-11. DECADE DIVIDERS — take the time base oscillator signal as the input and provide as an output a pulse train whose frequency is variable in decade steps. The operator can control this frequency with the FREQ RESOLUTION, N switch. The time, t, of equation (1) is determined by the period of this pulse train.

4-12. MAIN GATE — is the heart of the counter. When this gate is opened, pulses from the amplifier/trigger are allowed to pass through. The opening and closing of the main gate is controlled by the decade divider output to the main gate flip-flop.

4-13. DECADE COUNTING ASSEMBLIES — totalizes the output pulses from the main gate and displays this total after the gate is closed. If, for example, the gate is open for precisely 1 second, the decade counting assemblies (DCA's) display the frequency, in Hertz, of the input signal.

4-14. Other basic measurements the counter can perform are described in the following paragraphs.

4-15. Period

4-16. Period, the inverse of frequency, can be measured with the counter by reversing the inputs to the main gate. Now the input signal controls the duration over which the main gate is open and the decade divider output is counted by the DCA's. The duration of the count is, of course, one cycle or period of the input signal (see Figure 4-2).

4-17. Unused decades in the decade divider chain can be used to divide the amplifier/trigger output so that the gate remains open for decade steps of the input period rather than a single period. The is the basis for multiple period averaging. Period and period averaging techniques are used to increase measurement accuracy on low frequency measurements.

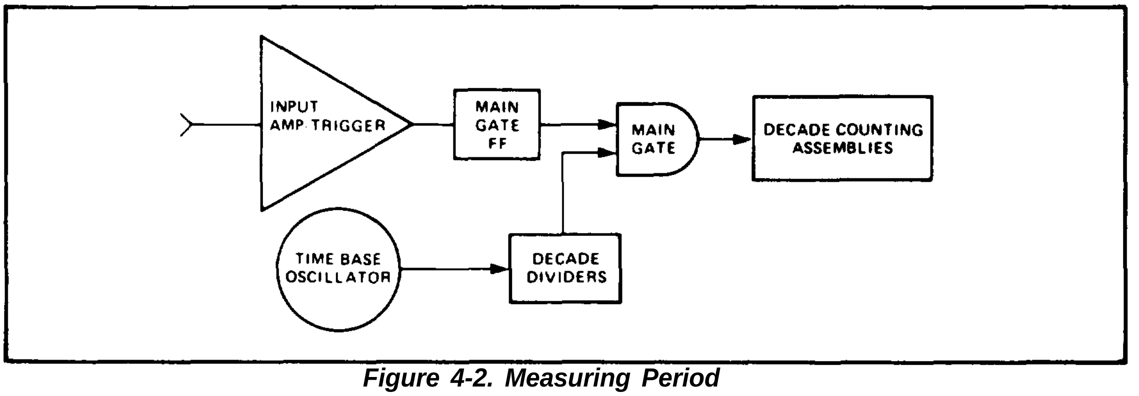


Figure 4-2. Measuring Period

NOTE

The roles of the amplifer/trigger and decade divider outputs are reversed in measuring the period. This same configuration also serves for ratio measurements with the second input replacing the time base oscillator.

4-18. Ratio

4-19. By replacing the time base with a second input of frequency, f_2; the same configuration as in Figure 4-2 can be used to measure the ratio f_2/f. For higher resolution the signal at frequency f can be divided in decade steps in a manner identical to multiple period averaging.

4-20. Time Interval

4-21. Figure 4-3 shows the configuration for the measurement of time between two events or time interval. The main gate is now opened by the START input and closed by the STOP. The decade divider output is again counted and the display shows the elapsed time between START and STOP signals. The measurement of time interval is considered in more detail in paragraph 4-22.

4-22. TIME INTERVAL, RESOLUTION, AND AVERAGING TECHNIQUES

4-23. Time interval, the measurement of the time between two events, is shown in the block diagram shown in Figure 4-3. The main gate is now controlled by two independent inputs, the START input opening the gate and the STOP input closing it. Clock pulses are accumulated for START and STOP. This is shown in Figure 4-4.

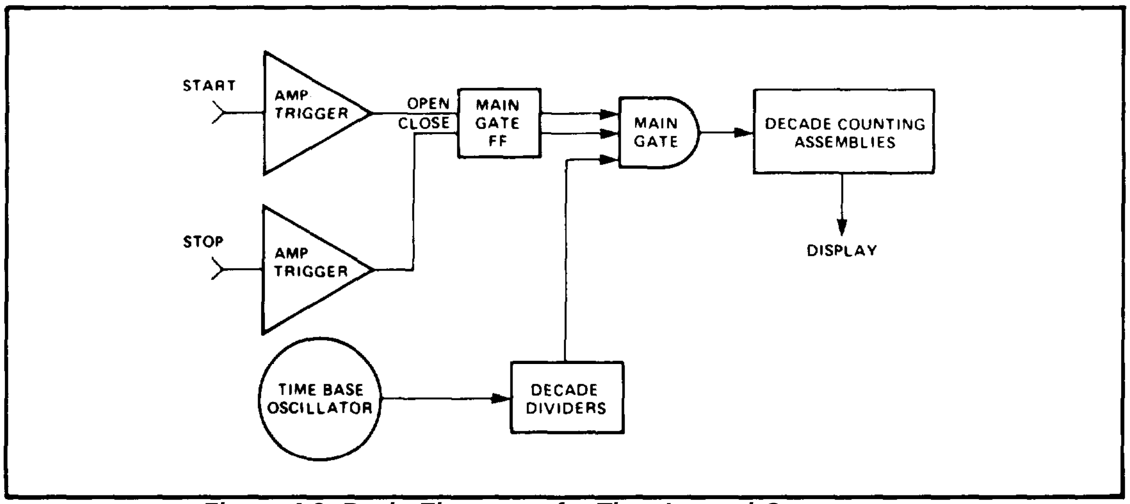


Figure 4-3. Basic Elements of a Time Interval Counter

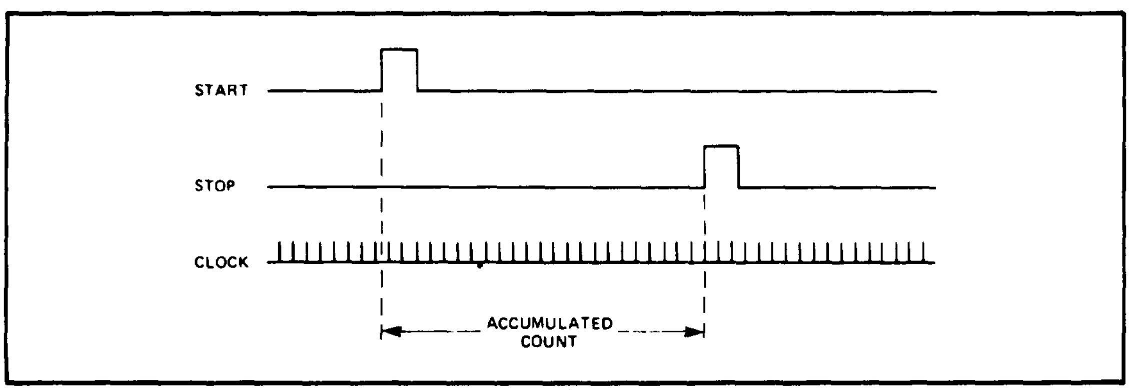


Figure 4-4. Clock Pulses

NOTE

In a time interval measurement, clock pulses are accumulated for the duration the main gate is open, The gate is opened by one event, START and closed by the other, STOP.

4-24. Resolution

4-25. The resolution of the measurement is determined by the frequency of the counted clock (e.g., a 10 MHz clock provides 100 ns resolution). The elements within the time interval counter (input amplifier, main gate, DCA's) must operate at speeds consistent with the clock frequency, otherwise the instrument's resolution would be meaningless. The 5328A counts a 10 MHz clock.

4-26. Clock frequencies of 1, 10, 100 MHz, and other 10^n frequencies, are preferred since the accumulated count, with the appropriate placement of decimal point, gives a direct readout of time interval. This explains why the conventional time interval counter is at present limited to 10 nanoseconds, a clock frequency of 100 MHz. 1 GHz is beyond reach and a clock frequency of 200 MHz would require some arithmetic processing of the accumulated count in the DCA's to enable time to be displayed directly.

4-27. Time Interval Averaging

4-28. This technique is based on the fact that if the ±1 count error is truly random it can be reduced by averaging a number of measurements. The words "truly random" are significant. For time interval averaging to work, the time interval must (1) be repetitive, and (2) have a repetition frequency which is a synchronous to the instrument's clock. Under these conditions the resolution of the measurement is:

$$\text{Resolution} = \frac{\pm 1 \text{ count}}{\sqrt{N}}$$

where N = number of time intervals averaged

4-29. With averaging, resolution of a time interval measurement is limited only by the noise inherent in the instrument. Ten picosecond resolution can be obtained with the 5328A. Most time interval averaging suffers one severe limitation; the minimum measurable time interval is limited to the period of the clock. This limitation is removed by circuits known as synchronizers which are used in the 5328A to measure intervals as short as 100 picosecond.

4-30. The 5328A synchronizers operate as shown in Figure 4-5. The top waveshape shows a repetitive time interval which is asynchronous to the square wave clock. When these signals are applied to the main gate, an output similar to the third waveform results (no synchronizers). Note that much of this output results in transitions of shorter duration than the clock pulses. DCA's designed to count at the clock frequency are unable to accept pulses of shorter duration than the clock. The counts accumulated in the DCA's will therefore approximate those shown in the fourth trace — the exact number of counts is indeterminant since the number of short duration pulses actually counted by the DCA's cannot be known. Since the time interval to be measured is slightly greater than the clock period, the fourth waveshape shows that the average answer will be in error, having been biased, usually low, because of the DCA's requirement of having a full clock pulse to be counted.

4-31. This problem is alleviated by the synchronizers which are designed to detect leading edges of the clock pulses that occur while the gate is open. The waveshape applied to the DCA's, when synchronizers are used, is shown by the fifth waveform. The leading edges are detected and reconstructed, such that the pulses applied to the DCA's are of the same duration as the clock.

4-32. Synchronizers are a necessary part of time interval averaging; without them the averaged answered is biased. In addition, it may easily be seen that with synchronizers involved, time intervals of much less than the period of the clock can be measured, This technique is only as good as the synchronizers, however. The 5328A high-speed synchronizers enable intervals as small as 100 picosecond to be measured.

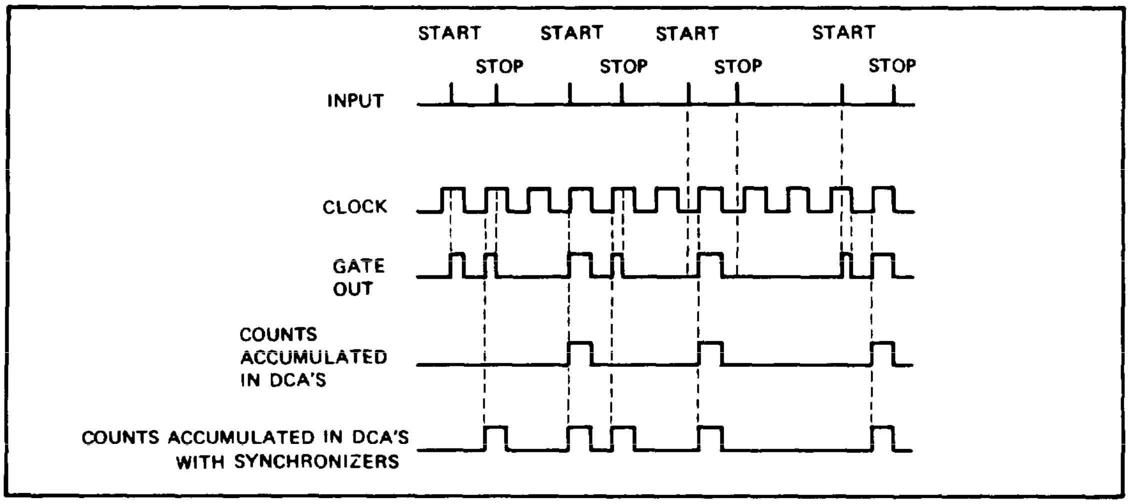


Figure 4-5, Synchronizer Operation with Time Interval Averaging

4-33. There are occasional situations where time interval averaging cannot be performed on a periodic signal. This problem occurs when the input time interval repetition rate is synchronous with the internal clock.

4-34. SOURCES OF MEASUREMENT ERROR

4-35. The major sources of measurement error are the ±1 count ambiguity, the time base error and trigger error. These are discussed in the following paragraphs.

4-36. ±1 Count Ambiguity

4-37. Since the signal input to the main gate of the counter and the clock input are not coherent, an inherent ±1 count ambiguity exists in the count accumulated in the decade counting assemblies. This is illustrated by Figure 4-6.

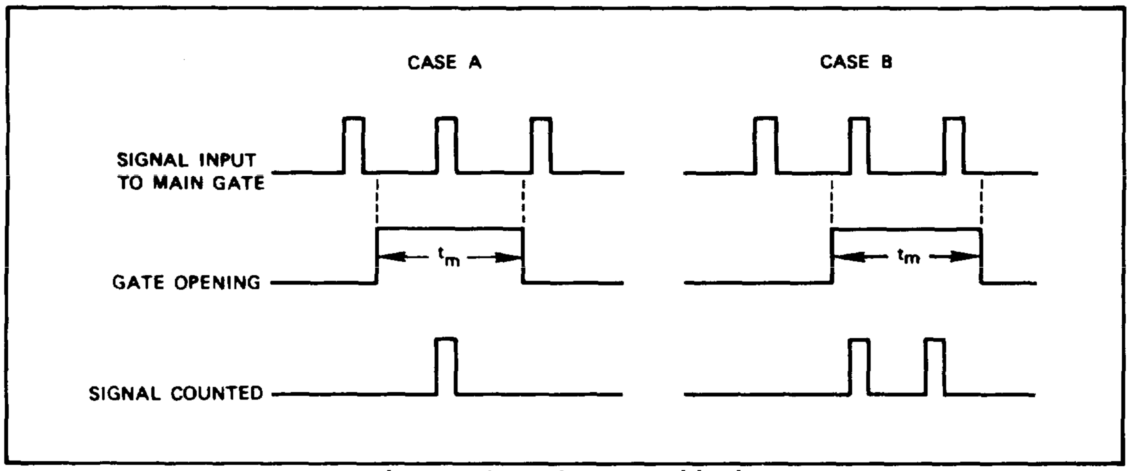


Figure 4-6. ±1 Count Ambiguity

NOTE

The main gate is open for the same time, t_m, in both cases. incoherence between the clock and the input signal can result in two different counts which for this example is one for case A and two for case B.

4-38. FREQUENCY MEASUREMENT ERROR. The error caused by the ambiguity is in absolute terms, ±1 of the accumulated count. For a frequency measurement the signal counted is the input signal of frequency, f_{in}. Thus the relative error is given by:

±1 count error, relative frequency measurement error

$$\frac{\Delta f}{f} = \frac{\pm 1}{f_{in}} \qquad (2)$$

4-39. PERIOD MEASUREMENT ERROR. For period measurement, the signal counted is the internal time base clock of period t_c. Hence the relative error becomes:

±1 count error; relative period measurement error

$$\frac{\Delta T}{T} = \frac{\pm t_c}{T_{in}} \qquad (3)$$

4-40. MAIN GATE REQUIREMENTS. The ±1 count error described above assumes the main gate itself does not contribute any error. As with any gate, however, the main gate does exhibit propagation delays and takes finite times to both switch on and off. Any differential between the times taken for the main gate to switch on and off show up as uncertainties in the length of time the gate is open. This uncertainty in turn translates into a measurement error that increase the ±1 count. However, the uncertainty in the main gate of the 5328A is substantially less than the period of the highest frequency counted, so this error is not appreciable.

4-41. Time Base Error

4-42. Any error in the time base oscillator directly translates itself into a measurement error. Thus, if the total of all the oscillator errors amount to 1 x 10^{-6}, the total error contributed by the time base in the measurement of a 10 MHz signal is 1 x 10^{-6} x 10^{7} = 10 Hz. Similarly, for the measurement of a 100-millisecond period, the error would be 1 x 10^{-6} x 10^{-1} = 1 x 10^{-7} or 100 nanoseconds.

4-43. Trigger Error

4-44. Noise on the input signal will cause uncertainties in the point at whit} the Schmitt trigger switches. Provided the noise is not large enough to cause false triggering (i.e., cross both limits of the hysteresis band which would produce more pulses out of the Schmitt trigger than input cycles to it) no significant error is introduced in a frequency measurement.

4-45. For period measurements, however, this uncertainty produces like error in the time the gate is open, since it is this signal that controls the gate. It can be shown that with essentially low frequency noise and a signal-to-noise ratio of 40 dB, the resultant worst case trigger error is .32% of the period. Thus, the trigger error in the measurement of the period of a 1 kHz signal is 3.2x 10^{-3} x 10^{-3} = 3.2 microseconds, worst case. For 60 dB signal-to-noise ratio, worst case error is .032%; while for a 20 dB signal-to-noise ratio signal it is 3.2%.

4-46. For an arbitrary wave shape (but constant slew rate through the hysteresis band), the trigger error takes on a different expression. In Figure 4-7, it is shown that for this case, the trigger error is:

$$\frac{\pm 2 \text{ peak noise voltage}}{\text{signal slew rate}}$$

for a 40 dB S/N, this translates to:

$$\frac{\pm .0025\ \mu s}{\text{signal slew rate } (V/\mu s)}$$

4--47. For time interval measurements, trigger error is generally negligible when compared to the systematic error introduced by the uncertainty in the setting of trigger levels. For an uncertainty in trigger level of ±10 millivolt and a peak noise voltage of one millivolt, trigger error is a factor of five less than the error caused by trigger level uncertainty, regardless of signal slew rate. For example, trigger level uncertainty of ±10 millivolt on a 100 millivolt/nanosecond signal introduces an error in the time interval measurement of ±0.1 nanosecond. The trigger error for such a signal, with 1 millivolt peak noise, is less than ±.02 nanosecond, a factor of five less. Averaging reduces the trigger error still further (but not the trigger level uncertainty error). The error is reduced by $\sqrt{N}$ for time interval averaging and by N for period averaging.

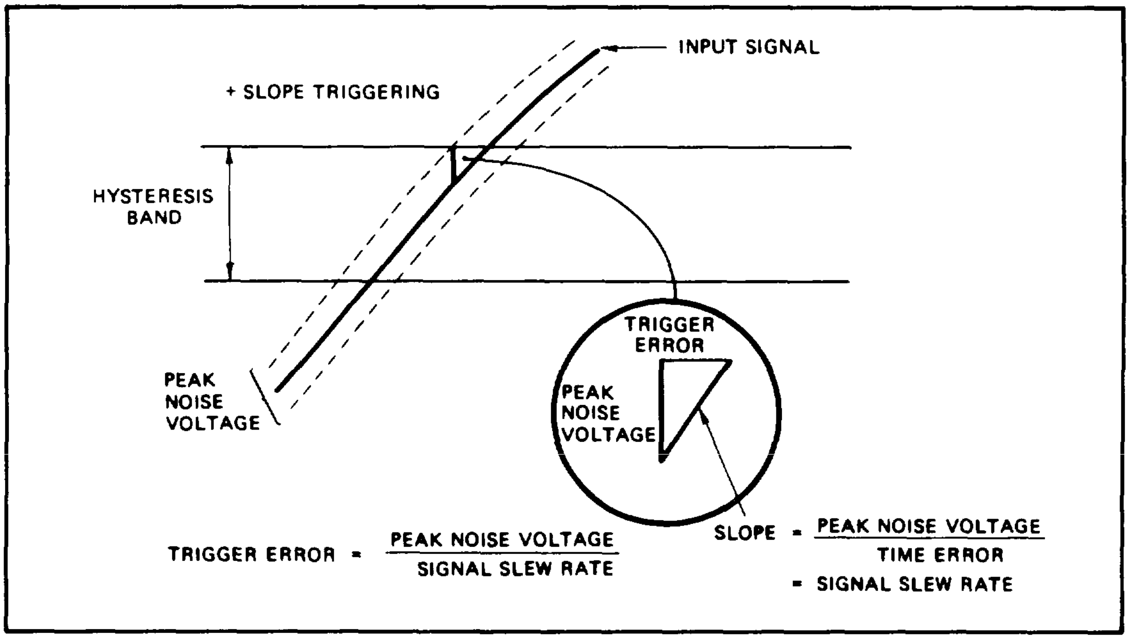


Figure 4-7. Trigger Error

4-48. 5328A PRINCIPLES OF OPERATION

4-49. The 5328A is organized into four main operating sections (refer to Figure 4-8):

- The main counter section
- The input section
- The power supply section
- The Hewlett-Packard Interface Bus (HP-IB) section

4-50. Each section operates relatively independently and communicates to the other through an internal bus system. The two-way bus consists of 90 lines.

4-51. The power supply provides regulated dc voltage for the other operating sections of the instrument. The main on-off switch of the instrument operates only the central power supply regulator; the main ac power line is never broken. Unregulated dc is constantly fed to the oven oscillator eliminating the need for time base warmup. The fan is dc powered.

4-52. Main Counter Section

4-53. The main counter section on A1 Motherboard contains all of the functional subunits of a standard counter with the exception of input signal conditioning and special logic, which are contained in the input section. The decade counting assembly contains eight decades of BCD counting logic, latches, and output multiplexing logic. The time base assembly contains eight

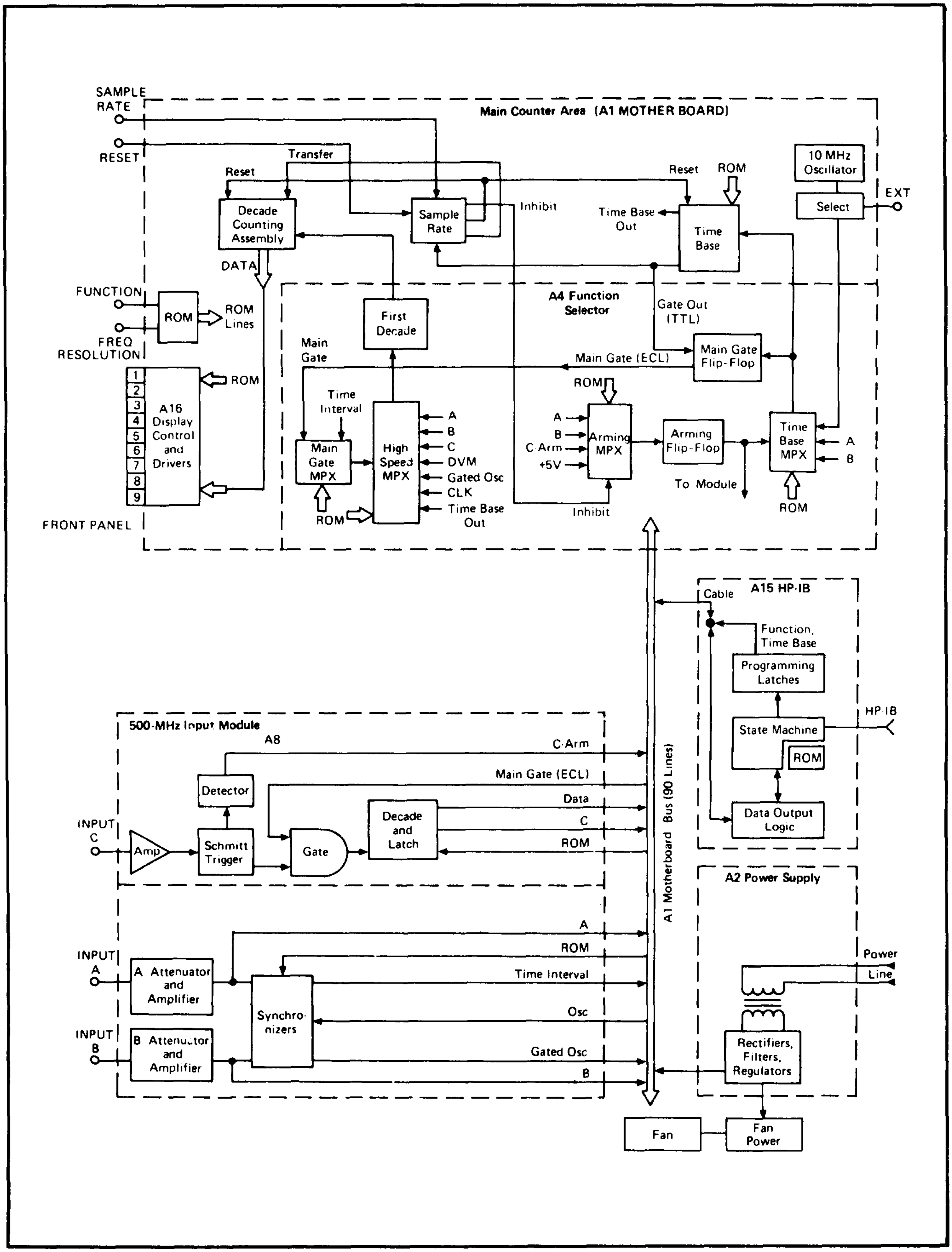


Figure 4-8. Block Diagram

counting decades, output multiplexing logic, and synchronizers to generate precise timing signals for the main gate. The oscillator section contains the input/output logic to accept an external signal via the rear panel or an internal signal from the oven-regulated crystal oscillator.

4-54. The sample rate circuit controls the instrument display cycle. ınhibit, reset, main gate, transfer, and sample rate signals are generated in this circuit, as is the BCD digit address code for the strobed display. Generation of decimal point and annunciators and decoding of BCD data are accomplished by the display control circuits. Data out of the decade counting assembly or the input modules is decoded and displayed on the nine-digit LED display.

4-55. The A4 Function Selector serves as the main signal switch of the instrument. It routes input signals through multiplexer to the decade counting assembly and/or the time base. At the same time, it interacts with the display control circuits to determine the beginning and end of the display cycle. The precision main gate signal is created on the function selector through interaction with the time base assembly. The function selector also has extensive interaction with the input modules. It is the main receiver of the high-speed data from the modules and the originator and receiver of module arming pulses.

4–56. The flexibility of the 5328A comes from the ability of all these operating subsections to accept diverse data from input modules. This is accomplished through the use of a 4000-bit read-only memory (ROM) as the master control of the instrument. Located in the main counter section of the instrument, the ROM accepts the four-bit function code and the three-bit time base code from the front-panel switches or the HP-IB remote programming board. The ROM generates 32 bits of output data which are transmitted throughout the instrument to set-up each subsection for the particular measurement situation.

4-57. Input Section

4-58. The input modules are the main interface between the instrument and the outside electronic environment. They accept input signals and convert them into the proper form to be handled by the main counter circuits.

4-59. The middle area of the input module section provides the 5328A with extended frequency capability (Channel C). A 50Ω fuse-protected 500 MHz amplifier and Schmitt trigger feed the 500 MHz decade. Latches in this section strobe the ninth (least-significant) digit from the module onto the data bus and into the display. In functions not requiring an input from this module, ROM lines deactivate the output strobing circuitry and the ninth digit on the display goes blank.

4-60. Hewlett-Packard Interface Bus (HP-US) Section

4-61. The fourth section of the instrument, the HP-IB assembly provides for control of the counter by the HP-IB. Connected to the main instrument bus through a ribbon cable, the internally-mounted HP-IB board controls function, time base, cycle rate, arming, and other controls in the instrument.

4-62. A1 MOTHERBOARD

4-63. The A1 Motherboard consists of five sections, as follows:

a. Display control.
b. State control.
c. Oscillator.
d. Decade Counting Assembly.
e. Time Base.

4-64. Display Control

4-65. The display control section on Al Motherboard acts as an interface between the A16 Display board and the other circuits of the counter.

4-66. The outputs of the A16 Display Board FUNCTION and RESOLUTION switches go to the ROM (A1U37). The outputs of the ROM position the decimal point and annunciators in the display and provide control functions for other circuits of the counter. Data from the data bus is translated from BCD to seven-segment form in decoder U41 and sent to the display which is strobed by U39. U39 decodes the digit address code from BCD to one of 10 forms. Leading zero blanking is provided by the latch comprised of U32B and U40B. Latches U25, U26, U27, and U31 provide outputs related to function and time base codes for use in other sections of the instrument.

4-67. State Control

4-68. The state control section is comprised of circuits U1, U2, U3, U4, and US. Decade Counter U1 generates the digit select strobe code for the display. Circuit U4 receives the Sample Rate signal and generates the main Reset, Transfer, and Inhibit signals.

4-69. A3 OSCILLATOR SUPPORT

4-70. An oven-temperature-regulated crystal oscillator (A3A1) supplies the precision 10 MHz time base signal in the 5328A. The A3A1 crystal oscillator (also designated HP Model 10544A) is in rectangular metal enclosure which plugs into the A3 Oscillator Support. The A3 Oscillator Support in turn plugs in the A1 Motherboard.

4-71. A3 Oscillator Support

4-72. On the A3 Oscillator Support five separate functional circuits are provided: a voltage regulator, an external signal detector, and amplifier-multiplier, a multiplexer, and a 10:1 divider. Integrated circuit U3 is a voltage regulator which regulates the 25-volt power at about 13 volts for the oscillator. External signal detector U4C will detect if an external signal (1, 5, or 10 MHz) is applied to the 5328A rear panel EXT OSC IN connector and send a signal, U4C(13), to control the U2 multiplexer. If an external oscillator signal is applied, the multiplexer selects the external signal for the 5328A time base. If only the A3A1 10 MHz signal is available, it is used for the time base. U4A and B produce a 10 MHz output, U4B(5), with either 1, 5, or 10 MHz input. The A3A1 10 MHz is divided to 1 MHz by U1 for the rear panel 1 MHz OUT connector.

NOTE

The rear panel 10 MHz OUT and 1 MHz OUT are both always derived from the 10544A, A3A1 Oscillator.

4-73. A3A1 Oscillator (HP 10544A)

4-74. The oscillator specifications are given in *Table 7-3.* This oscillator is a factory-serviced assembly. No circuit description is given here.

4-75. DECADE COUNTING ASSEMBLY (DCA)

4-76. The 5328A DCA is comprised of Decade Counter/Latches (U10 and U12) on the A1 Motherboard and U1A, U3, and U4B on A4 Function Selector Board, The Motherboard contains output enable circuitry (U6, U7, and U9) for controlling the counters output data, signal overflow indication, and circuitry for strobing data into the display (U41). The data output of each Decade Counter in the DCA corresponds to a digit on the display. The first Decade Counter in the sequence of operation corresponds ‘to the least-significant-digit and the last to the most-significant-digit. Digits 0 through 5 are processed by U12, digit 6 by U10, and digit 7 by U11.

4-77. All measurements performed by the 5328A result in pulses being counted in the DCA. Pulses are admitted to the DCA by way of the Main Gate FF on A4 which is either controlled by a Gate Out signal from the Time Base (A1U19) or held open by the HOPN signal from A1U25.

4-78. Data strobe signals, transfer pulses, reset pulses, and an output disabling signal are routed to the DCA via the 5328A State Control Circuitry. These signals are processed in the DCA and are used to control transfer of the counter's output data to the latch outputs, strobe this data onto the Data Bus, disable the outputs that feed into the Data Bus, and reset the counters after a measurement cycle is over.

4-79. TIME BASE

4-80. The 5328A Time Base circuit is comprised of an 8-decade divider U21, shaping flip-flop U19A, and Synchronization flip-flop U19B. The Time Base input, depending on the particular measurement being made, is either the 10 MHz system clock or the Channel A or B input signal. These signals are routed to the Time Base input via the ROM-controlled Time Base Multiplexer, U10 on the A4 Function Selector board.

4-81. The Time Base circuit has two modes of operation consistent with the two types of measurements performed by the 5328A. For frequency and time interval type measurements, the Time Base circuit generates a gate during which either oscillator or input pulses are counted. For totalize type measurements, the Time Base circuit divides its input by N as set on the RESOLUTION, N switch on the front panel and outputs the divided signal to be counted in the DCA. The outputs of the Time Base circuit, corresponding to both operating modes, are generated simultaneously. Regardless of the type of measurement being performed, these outputs are made available to the A4 Function Selector which selects the proper signal to perform the function.

4-82. The length of the gate time generated by the Time Base circuit and the scale factor of the Time Base Input is determined by the Time Base code. The 5328A Mainframe ROM reads the codes of both the Time Base (RESOLUTION, N) and FUNCTION switches and outputs the proper code to the Time Base such that measurement resolution and scale factor agree with the information in the various (RESOLUTION, N) switch positions.

4-83. A2 POWER SUPPLY

4-84. The power supply has five output voltages: +5, -5.2, +15, -15, and +3.5 volts, dc. The +5V and -5.2V circuits are essentially the same as are the +15V and -15V sections, so only the positive voltage sections will be described.

4-85. +5V Supply

4-86. The +5V supply is a switching regulator that has greater efficiency than a linear regulator of the same output, When the output voltage is below its nominal level, comparator U1 sees its + input being above its - input and hence its output goes positive turning on transistor Q5 which in turn turns on Q3 and Q1. The voltage at the collector of Q1 now goes high (greater than 17V) and current starts to build up through L1, charging the output capacitor and increasing the output voltage. At the same time positive feedback is provided via resistor R11 to maintain the situation until the output goes slightly above +5V. When the voltage reaches this point the comparator output voltage starts to fall turning off transistors Q5, Q3, and Q1 causing the voltage at the collector of Q1 to fall. This provides positive feedback via resistor R11 to reinforce the charge. As a result, transistors Q5, Q3, and Q1 are turned off hard, and the voltage at the collector of Q1 goes negative, except for diode CR3 which clamps the voltage to ground. During this part of the cylce, current flows through diode CR3 and coil L1 allowing the energy which has been stored in the field of L1 to go into the load. This goes on until the output voltage again goes low enough to overcome the offset at the input of comparator U1 and turn transistor Q1 on again.

4-87. +15V FAN POWER. The +15V supply is a simple linear regulator using transistor Q7 as the pass transistor. Transistor Q2 provides level shifting and current gain while U3 is used as comparator and gain block. The 5328A cooling fan motor receives power from A20. A20 is a sealed unit which produces an alternating current from +15 volts input.

4-88. The +3.5V supply is also a simple linear regulator with the operational amplifier section of U5 being used as a comparator and gain block. Resistor R32 provides overcurrent limiting to protect against shorts.

4-89. A4 FUNCTION SELECTOR

4-90. The A4 Function Selector serves as the main high-speed switching module of the 5328A. It receives high-speed differential ECL data from the Main Bus (from the modules that process the signal input) and routes that data to either the Time Base or the DCA. In addition, the Main Gate FF, the Arming Multiplexer and Arming FF, and the First Decade of the DCA are on the A4 Function Selector assembly.

NOTE

Refer to Table 8-7 for definitions of mnemonics.

4-91. High Speed Multiplexer, Main Gate, and 1st Decade

4-92. High speed multiplexer U6 serves as the main multiplexer and routes the following signals to the 1st decade of the DCA: A, B, GATES OSC (GOSC), C, DVM, TIME BASE OUT (TBO), and OSCILLATOR (OSC). ROM lines IA, IB, and IC control the active address of the multiplexer. Pin 2 (enable) of the multiplexer serves as the Main Gate. The Low Time Interval (LTIF), Low Main Gate FF (LMGF), or (LTOTŽLST), signal operating through U8 and enabled by ROM lines LMGF, LTIF, (LTOTŽLST), respectively control the Main Gate. In addition, ROM line HOPN can override LTIF or LMGF and lock open Main Gate U6(2) through U8C. Main Gate status is detected and sent off the A4 Function Selector by ECL-to-TTL translator U2D. Capacitor C11 and resistor R35 serve to stretch any ECL gate signal present at U2(10) so that the slower TTL control chip A1U4 and gate light one-shot (Q6, U36B, E) can see the pulses and properly react. U8D differentially drives bus lines MG and M to operate the remote Main Gate of Channel C.

4-93. The output of the main multiplexer U6(15) feeds into first binary U1 of the main DCA. U1A is an ECL High-Speed binary the output of which couples to pins 14 and 15 of ECL-to-TTL translator U2. The TTL output of U2(13) clocks Schottky quinary U4 and U3. The outputs of the first decade U3(9), U4(9), U3(5), and U2(13) travel off the A4 Function Selector board to the DCA on the Al Motherboard where they are latched and the carry feeds into the next decade of the DCA.

4-94. Arming Multiplexer and Arming FF

4-95. The Arming FF, the second half of U4, serves to inhibit various measurements by enabling or disabling Time Base Multiplexer U10 and the synchronizers in the Universal Module. This action occurs via the High Disables Syncrhonizers (HDS) signal from U4(6). The signal which sets or enables U4 comes from Arming Multiplexer U5(6). ROM lines control U5(10, 11) while the remaining address line (pin 9) is controlled by the Low Arm (L ARM) signal from the rear panel ARM switch. US thus selects either C-ARM, B, B, or free run (+5V) as the signal to send to U4 as the Arming signal. The A and B signals are derived from ECL-to-TTL translator U2A and U2B, respectively. Capacitors C4 and C5 and resistors R17 and R18 serve as pulse stretcher timing elements to enable the narrow ECL pulses on lines $\overline{A}$ and $\overline{B}$ to be seen by the TTL Arming FF U4.

4-96. Time Base Multiplexer and Main Gate FF

4-97. Time Base Multiplexer U10 select either A, B, or OSC to send the Time Base Input (TBI) signal via pin 8 to the Time Base. This same signal is also sent to U1, the Main Gate FF, as a desynchronizing signal. ROM lines R(HTBA), R(HTBO), and R(HTBB) control the selection of the Time Base Input signal. The HDS signal to U10(3) or ROM line LTOT to U10(1) serve to enable or disable U10.

4-98. U1B is a high-speed ECL FF used to generate precise stable gate times for the Main Gate Multiplexer U8 and the remote gate in the Frequency C module. A TTL replica of the Main Gate signal (GATE OUT) is generated in the Time Base and sent to U1 via the line Main Gate Synchronizer on the Motherboard. Resistors R14 and R43B translate this TTL signal down to ECL levels at U1(10). The output of Time Base Multiplexer U10 via resistors R42 and R43D and capacitor C16 clocks U1(11) yielding a synchronized fast rise and fall time Main Gate signal on U1(14).

4-99. An Example of Operation

4-100. To show how the above mentioned function selector circuits operate together an example of the measurement of frequency A is given in the following paragraphs.

4-101. Assume the counter is in the middle of its display cycle. Low Inhibit (LINH) is TTL low, High Reset Time Base (HRTB) has momentarily gone high resetting U1 and U4 and High Reset Decade (HRD) has momentarily gone high resetting First Decade U1, U4, and U4. The control chip on the Motherboard releases LINH to go high. U9(13) goes low enabling Arming Multiplexer US. Assuming that self arm has been selected, A will have been dected by the ROM , on pins 9, 10, and 11 of U5. When the first A pulse occurs U4(4) goes low setting U4. U4(5) goes high turning on transistor Q1 which in turn pulls LINH low again and inhibits another measurement from starting until Reset has occurred. In a frequency measurement, the ROM selects the Oscillator signal on pin 2 of U10 to be sent into the Time Base. Shortly after the Time Base returns, a high signal on Main Gate Synchronizer drives U1(10) high. On the next Oscillator signal (through U10) U10(11) gets clocked causing U1(14) to go low. This low signal propagates through U8(B and C) to U62) opening the Main Gate and initiating the count, Signal A has been selected on U6 by ROM lines R22, 23, and 24 thus each A event is counted into 1st decade U1A, U4A, and U3.

4-102. After the appropriate gate time has elapsed (N clock counts into the Time Base) the Main Gate Syncrhonizer signal goes low and the next Oscillator signal clocks Main Gate FF U1 closed. U2(10) detects the closing of the Main Gate and sends a TTL signal (LMGF) to U4 in the State Control section of the Al Motherboard which initiates a new display cycle.

4-103. A16 DISPLAY ASSEMBLY

4-104. The Display Assembly contains the display, as shown in the block diagram in Section Vlll, in addition to switches S1 (POWER), S2 (RESET), S3 (FUNCTION), S4 (FREQ RESOLUTION, N) and SAMPLE RATE control R6 as shown in the schematic diagram in Section Vlll.

4-105. The display consists of a nine-digit seven-segment LED numeric display (DS1-DS9) and annunciators for indicating measurement units (DS10-DSI6) in addition to overflow (DS17), remote (DS18), and gate (DS19). The display digits and annunciators are automatically displayed with the correct decimal point.

4-106. The digit address code from A1U39 on the Motherboard is applied to transistors Q1 through Q9 to strobe each digit which receives the seven-segment code from A1U41 through transistors Q13-Q20. The gate (DS19), remote (DS18), and overflow (DS17) LED’s receive signals from the Motherboard through transistors Q10, Q11, and Q12, respectively.

4-107. REMOTE CONTROLLABLE (PROGRAMMABLE) INPUT BLOCK DIAGRAM DESCRIPTION

4-108. In the local mode, the A19 Switch Control board generates TTL levels that control the A12 signal conditioning relays. These levels allow front panel control of A and B channel input signal conditioning. The A19 board accepts inverted A and B channel signals from the A12 board. These signals are routed through pulse stretcher and driver circuits to the A and B channel trigger LEDs located on the A19 board. The inverted signals are also translated from ECL to TTL levels and supplied to the A and B marker outputs.

4-109. Input circuitry for the A and B channels is on the A12 Amplifier board and part of the A10 Synchronizer board. The A12 board contains the 100 MHz A and B channels with signal conditioning SLOPE, AC/DC, ATTENUATORS, SEP/COM, amplifiers, and Schmitt triggers. Signal conditioning circuitry is controlled by relays K1 through K12 synchronizing circuitry for period and time interval type measurements. The A, $\overline{A}$, B, $\overline{B}$, TI, $\overline{TI}$, GOSC, and $\overline{GOSC}$ outputs, from the A10 board, are routed to the A4 Function Selector.

4-110. The programming interface section of A10 board is used to allow remote control of all input signal conditioning relays. The A11 DAC board contains two identical DACs, A and B channel, that allow remote control of trigger levels. The outputs of these DACs are supplied to a relay on the A12 board. In remote, the relay connects these DAC levels to the Schmitt trigger on the A12 board. There are two modes of accepting remote commands, the non-DAC and DAC control modes.

4-111. When the 5328A goes into remote, front panel switch control is disabled. At the same time, the programming interface takes control of the input signal conditioning relays. In the non-DAC control mode, the interface accepts and decode serial data bytes, stores the information in latches, and control signal conditioning via the latched outputs.

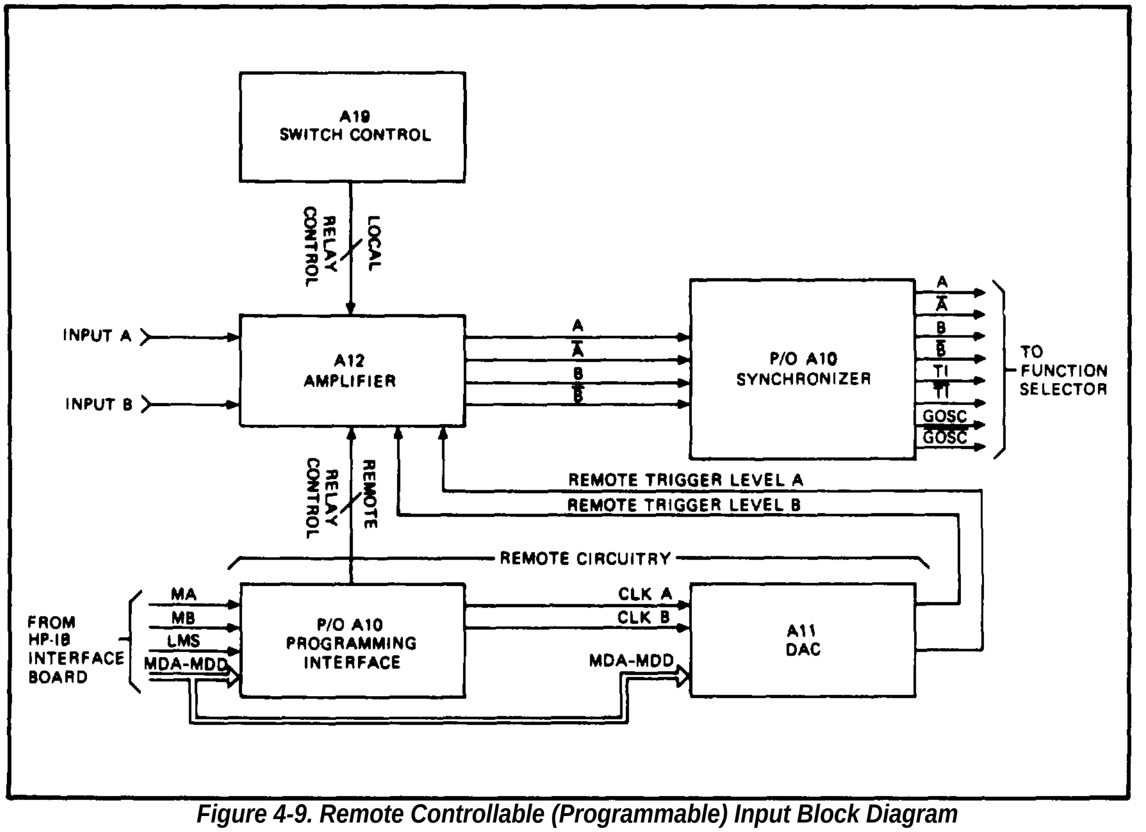


Figure 4-9. Remote Controllable (Programmable) Input Block Diagram

4-112. When the interface receives a data byte, for control of trigger levels, it goes into the DAC control mode. This is a result of the interface receiving a + or - on its input data lines. Once in the DAC control mode, the programming interface latches disregard the information at their input. Simultaneously, the information, on the input data lines (MDA-MDD) is accepted by the A11 DAC board.

4–113. The A11 DAC board shifts the polarity indicator and three following numerical bytes of information into its shift registers. Following the polarity indicator and the three numerical data bytes, an asterisk (*) appears on the MDA-MDD lines (see Table 4-7 for proper format). The asterisk causes the programming interface to revert back to the non-DAC control mode. In this mode, the All board stops accepting data, and the programming interface latches again accept the input data.

Table 4-1. 5328A Input Circuit *Program Code Set*

Programming is accomplished as detailed in Section Ill with the additions below. Codes shown underlined are start up conditions. These conditions are set by the code “P”, Remote Programm Initialize, or by the bus commands Device Clear, or Selected Device Clear.

Commands to A channel are preceded by A
Commands to B channel are preceded by B

Trigger levels are programmed using the following format

±X.Y Z*

Where X is volts
Y is 100 s of mV
Z is 10 x of mV
* is used to terminate inputs to the DAC’s

Control	Function	Code
Coupling	AC	2
	DC	3
Slope	+	4
		5
Atten	X100	1
	X10	6
	x1	7
Separate/Corn	Separate	A8
	Common A	A9

NOTE
Underlined codes are default conditions.

Control	Function	Code
Invert	Normal	B8
	A&B Inverted	B9

The check function overrides all other programming commands for A&B channels.

EXAMPLES:

The instruction:

CMD “?U9”, “PF:G5S137A3579-1.25*B37+1.65*R”
Input circuits related programming information

Will program a 5328A with listen address of 9 to:

Function	Channel A	Channel B
Time Interval Avg A to B	DC Coupled	DC Coupled
Multiplier 10^5	-Slope	X1 Atten
Multiple measurement	X1 Atten	Trig Level +1.65V
Continuous Cycle	Common A	+Slope
Manual sample rate control	Trigger Level -1.25V	

4-114. The A11 DAC board processes the four serial data bytes, and produces one parallel BCD output. The BCD output provides the information for generating a square wave train by using a series of rate multipliers. The square wave train has an average duty cycle proportional to the input code supplied to the rate multipliers. This square wave train switches on a precision current source that feeds a voltage averager to produce a dc output.

4-115. REMOTE CONTROLLABLE (PROGRAMMABLE) INPUT SCHEMATIC THEORY

4-116. Theory of operation for the programmable input section is given in the following paragraphs.

4-117. A19 Switch Control Board

4-118. In local mode, -0.7 volts is applied to switches S1-S8. This potential allows the switches to control their respective functions by supplying an active low available at each switch. In a closed switch position, the -0.7 volts will forward-bias the associated diode, pull the anode low, and cause a low to be sent to the amplifier board through J3.

4-119. In remote mode, the -0.7 volts switches to +5 volts, only allowing the output lines, transmitted through J3, to be high. When a switch is open, the pull-up resistor on the line causes it to go high. When the switch is closed, the associated diode is reverse biased and the line remains high,

4-120. Trigger LEDs, DS1 and DS2, are driven by the inverted A and B outputs of the Schmitt trigger (A12U4). These signals enter pins 14 and 10 of ECL-to-TTL translator U1. Feedback capacitors C8 and C9 stretch the 5 nanosecond ECL pulse to approximately a 25 millisecond TTL output pulse. This 25 millisecond pulse is of long enough duration to be seen, and is used to drive the trigger LEDs. Since this pulse stretcher is decoupled to the Schmitt trigger, it functions like a logic probe with adjustable threshold voltage. When Channel A input is higher than the trigger level setting, the trigger LED is ON. When the input is lower, the LED is OFF, and whenever it passes through the trigger threshold, the LED flashes on or off depending on the polarity of the input signal.

4-121. The 5 nanosecond inverted A and B outputs are also applied to pins 2 and 6 respectively of U1. The signals are translated from ECL to TTL levels and connected to the marker outputs.

4-122. A12 Amplifier Board

4-123, Since both A and B channel circuitry are identical only the A channel will be discussed.

4-124. Input signal A enters A12 through J2 and depending on relay K7 is either ac coupled through capacitor c30 or dc coupled across relay K7. The signal then enters the three position attenuator (X1, X10, X100) and is passed from the selected attenuation node through either K2, K3, or K8 to the input of the FET impedance converter stage. Diodes CR5 and CR6, resistors R39, R37, and R34, and capacitors C23 and C24 form an overvoltage protection network to limit the signal sent to FET transistor Q3 and successive circuits to ±2.61 volts maximum, The signal at the node between resistors R30 and R32 follows closely the signal at the gate of Q3A. A potentiometer is used to adjust any initial offset voltage.

4-125. SEP/COM A relays, K4 and K5, connect the input of the B channel attenuator to either the A or B channel inputs. The signal then passes through U4, a dual Schmitt trigger, Trigger U4B compares the signal at pin 9 to a dc reference between ±2.5 volts on pin 10. This dc reference is selected by K1 and is supplied by either the A11 DAC board or by the A19Switch Control board. The output of U4 changes state whenever the input crosses the reference voltage on U4(11). The output is ECL (=-0.8 to -1.6V) and drives both the A trigger LED circuit on the A19 board

and the exclusive OR gate U2. Schmitt trigger U4 has approximately 15 mV peak-to-peak hysteresis at its input. Exclusive OR gate U2 is used to select the desired slope of the input waveform. When pin 7 of U2 is held to an ECL high level (SLOPE switch in + position), U2 acts as an inverter. When pin 7 goes low (SLOPE switch in the - position), U2 does not invert the signal passing through it.

4-126. Input signal conditioning control is accomplished by inverters U1 and U3 and relays K1-K12. This control is supplied from either the A10Synchronizer board or the A19Switch Control board. When the 5328A is in remote, relay control is received through J1 from the A10 board, In the local mode, relay control arrives via P2 from the A19 board. Since all of the relay control lines contain inverters, relay activation is caused by a high at the input.

4-127. A10 Synchronizer Board

4-128. The differential A channel outputs from A12U2 feedthrough connector P2 pins 7 and 8 respectively to U1. Circuit U4 is a one-shot that only triggers on a negative edge, and therefore, passes only trigger events that occur on the slope selected by A12U2. The output of U4 pin 15 is an ECL pulse of approximately 5-10 nanoseconds width. In the FREQ A check mode, the oscillator signal from U1(2), (either 10 MHz or 100 MHz as selected by S1) is injected via U5B to U10(13). The normal A input entering U10(12) is disabled at A12U4 by LCHK being low. The oscillator signal at U10(13) is passed through U10C and U10D to U11 a dual 4 to 1 multiplexer. In a noninverting mode, multiplexer U11 always routes the A channel signal to the start synchronizer U6A. In a period function, U11 routes the A channel signal to the stop synchronizer U6B. For time interval measurements, the B channel signal is supplied to stop synchronizer U6B. ROM line R6 controls the stop synchronizer input switching. In remote, HINV, from U11(7) allows the A and B channel outputs of U11 to be inverted. The outputs of U11A feed U12A which drives the A and A outputs to the A4 Function Selector.

4-129. In Tl, TI AVG, PER, and PER AVG functions, U5, U6, U12, and U13 are used to generate synchronized time interval and gated oscillator pulses for the mainframe. After a reset pulse arrives on the HDS line, the RS FFs US and U12 and D FFs U6A and U6B are reset. At the same time, the $\overline{TI}$ and $\overline{GOSC}$ outputs are at an ECL high. When a start event enters U5D pin 12, it sets the U5A output to U6A pin 7 high. The next clock pulse to U6(6) will cause U6A pin 3 to go low. This pulls the $\overline{TI}$ output low, signaling to the function selector that the time interval has started, When TI goes low, GOSC (U13B) starts to output oscillator pulses. When a stop event occurs at U5(10), the output of U12C goes high. This, synchronous to the next clock pulse, sets U16(15) high. When U16(15) goes high, the TI and GOSC outputs go high stopping the time interval measurement. The Q output of U6B through U13C, U14B, and U14A resets all FFs and thus prepares them for the next measurement.

4-130. ROM line RL6(HC), connected to U14(11) by R6, is used in period measurements. This line is set low in period, and holds the stop FF (U5C and U12C) off until the start synchronizer U6A clocks a high to its Q output.

4-131. In a PER AVG function where time base scaling takes place, ROM line RL5(T10) is driven high. This TTL high is converted to an ECL high, by resistors R18 and R21, and applied through U14D to U12(1)). This causes the stop synchronizer flip-flop (U5C and U12C) to remain in a reset condition.

4-132. The programming interface has two operational modes, the non-DAC and DAC control modes. These modes refer to the operation of the interface with respect to incoming data. When the incoming data is for control of signal conditioning (not trigger level) the interface will be in the non-DAC mode. The interface will be in the DAC control mode when incoming data is for DAC (trigger level) control.

4-133. When the 5328A goes into remote, LEXT goes low. The low, on LEXT, causes the output of A1 Motherboard switch control circuit to go from -0.7 volts to +5 volts. This change, disables front panel switch control on the A16 and the A19 boards. When LEXT is low, U17(4) connected to tri-state buffers U2 pin 1 and U9 pines 1 and 15 is also low. This low, returns the outputs of tri-state buffers, U2 and U9, to their active state. With the outputs of U2 and U9 enabled, the outputs of addressable latches, U8 and U15, control the A12 signal conditioning relays.

4-134. The interface is reset by a high on the HRPR line. This high is generated by the A15 HP-IB Interface Board when it receives an ASCII "P".

4-135. When the interface is reset it defaults to the non-DAC control mode. The reset causes the latched outputs of U8 and U15 to go low. This sets U17 pins 9 and 10 low, giving a low at U17(8), The low at U17(8) is connected to U7(14), where it causes the interface to be in the non-DAC mode. The low at U17(8) is also connected to clock multiplexer U16(1) where it causes U16 to route clock (LMS) pulses to only U8 or U15.

4-136. Clock multiplexer U16 decodes the MA and MB lines, from the A15 board, to determine whether the input data byte, on MDA-MDD, is A or B channel information. It then routes the clock pulse to U8(14) for A channel information, or to U15(14) for B channel information. The clock pulse, latches the information into the intended latch.

4-137. After reset, the interface defaults to all of the underlined functions in *Table* 3-5 Program Code Set. To change one of the signal conditioning controls it is necessary to program that function.

4-138. As an example, assume a Channel A function setting of X1 is desired. This means that an "A7" must be included in the data string sent by the system controller to the 5328A. When the "A" is decoded by the A15 HP-IB interface, it causes the MA line to be high and the MB line to be low. The MA and MB lines are decoded by U6 and it routes the following clock pulses to U8.

4-139. When the "7" is sent, 1110 appears at the input of ROM U7 on MDA-MDD respectively. As shown in *Table* 5-28, the 1110 at the input causes an output of 000011 on U7 pins 1-6.

4-140. The clock pulse arrives at U8(14) and latches the high on U8(13) to U8(5). The high on U8(5) is buffered by U9 and appears at pin 13 of its output. The high at U9(13) is inverted on the same function as Channel A.

4-141. All non-DAC information is latched in the same manner. B channel information is latched into the outputs of U15. it has the same code into U7, and thus the same code out of U7, for the same function as Channel A.

4-142. Refer to Table 3-5 Program Code Set for the proper format to program a trigger level. The proper format is ±X.YZ*, and follows an A and B which indicates to which channel it applies.

4-143. For the following discussion, assume a trigger level is programmed, following the proper format, and preceeded by an "A", The interface resets to the non-DAC mode when the A15 board receives an ASCII "P" from the system controller. When the A15 board receives the "A", the MA line is set high and the MB line is set low. U16 decodes the MA and MB lines, in the non-DAC mode, and clocks the A channel latch U8.

4-144. When a + or - appears on the MDA-MDD lines, a high is latched into U8(12), Latching occurs on the positive clock pulse transition from U16. The high at U8(12), will cause U17(8) to go high. U17(8) is connected to U7(14), where the high changes the input address to ROM U7, and locks the interface into the DAC control mode. The high at U17(8) is also connected to U16(1). A high at U16(1) causes U16 to supply clock pulses to either the A or B channel DAC.

Since the condition of the MA and MB lines remains the same, the Channel A DAC receives the clock pulses. On the negative transition of the clock pulse, the + or - is shifted into the A channel DAC shift registers A10U7 and U11.

4-145. Following the format, the next data byte on MDA-MDD will be a number. The MDA-MDD lines supplied to U7 are also connected to the A11 DAC board shift registers. Since the interface is in the DAC mode, neither U8 or U15 are clocked and thus disregard data on MDA-MDD. The number is clocked into the A channel DAC shift registers. The condition of the MA and MB lines, determines which DAC is clocked and accepts the number. Following the first number, a decimal appears at the input to ROM U7. When U7 decodes the decimal, it sends U7(5) high. This high, applied to U2(15), causes U2 to block the clock pulse associated with the decimal data byte. ın this manner, the DAC disregards the decimal.

4-146. Following the format, two more numbers are input, serially, and each clocked into the A channel DAC shift registers. The final character in the string, an asterisk (*), appears on the input data lines to U7. When U7 decodes the asterisk, U7(5) goes high, again blocking the positive clock pulse transition to the A channel DAC. This causes the A channel DAC to disregard the *. Simultaneously U7(6) goes low, allowing the negative transition of the clock pulse to latch the low at U8(13) into U8(12). The low at U8(12) causes U17(8) to go low, returning the interface to the non-DAC control mode.

4-147. A11 DAC Board

4-148. Since the DAC board contains two identical DACs only the Channel A DAC will be discussed. For the following description assume the Channel A DAC is programmed for a +2.22V trigger level. Refer to Program Code Set, Table 3-5, for an explanation of the format.

4-149. The first data byte, a +, appears on the input data lines MDA-MDD. This data byte is supplied to the inputs of shift registers U7 and U11. An LMS clock pulse routed through A10U6, applied to U7 pin 1, shifts the + into U7 and U11. The next three data bytes, all two's, are shifted into U7 and U11 in the same manner.

4-150. With the + and the three numerals shifted into U7 and U11, the shift registers provide a parallel BCD output. This parallel output is static until the A channel DAC is reprogrammed. The parallel output is supplied to the input of rate multiplier chain U8, U9, and U10.

4-151. Circuit USC and related components are configured as an oscillator. The oscillator output is coupled through Q7 to the clock input of rate multipliers U8, U9, and U10. The clock signal is also supplied through inverter U5D to D-FF U2A, which is used as a synchronizer and wave shaper.

4-152. With 1000 pulses entering pin 9 of each rate multiplier, the output at U10(6) will be 222 pulses, These pulses are supplied through level shifter and inverter U5B to U2(12), The input pulese are synchronized and shaped by U2A, The Q and Q outputs, from U2A, supply level shifter networks composed of resistors R31, R34, and R36, R38, and R39. The pulse outputs from the level shifter networks arrive at the cathode of CR6 and the anode of CR8.

4-153. The + shifted into U11, causes U6 pins 2 and 6 to go high, The highs, on pins 2 and 6, cause pins 1 and 7 to go low. The low at U6(1), causes CR11 to be forward biased. Forward biasing CR11 causes U6A to sink all of the current from the positive current source, This disables the positive current source U3A and Q3. With U6(7) low, CR12 is reverse biased enabling the negative current source U3B and Q4.

4-154. The signal at the anode of CR8 is the inverted output from the rate multipliers. When the anode of CR8 is low, CR8 is reverse biased, and current flows through CR10 into U4(2), When the anode of CR8 is high, CR8 is forward biased and current flows from Q4 through CR8

4-155. Averager U4 converts the current pulses supplied via CR10 into a dc output voltage. The averager generates the output voltage proportional to the duty cycle of the input current pulses.

4-156. A8 Channel C Input

4-157, The A8 board contains circuitry to amplify and detect input signals up to 500 MHz, a divide-by-10 counting chain, a high-speed gate, and circuitry to drive the least-significant-digit in the display.

4-158, The input signal enters J1 and continues through a fuse (F1) into a limiter circuit composed of diodes CR2-5 and a 50-ohm termination. Diodes CR2-5 have 70V reverse breakdown voltage and limit the signals below that value to approximately ±600 mV to protect amplifier U1. Fuse (F1) is rated at 125 mA and blows when the input voltage reaches about =7 volts. The signal passes through amplifier U1 (with a single ended gain of =4) and drives U2 (a combination amplifier/Schmitt trigger) differentially. The Schmitt trigger output (U2 pin 13) is a logic level from 0 volts to approximately -600 mV. The now digital (square wave) signal passes through U3 where it branches to drive a binary (U4) and a detector. The detector circuit senses the presence of an input signal and sends a TTL "C ARM" command to the A4 Function Selector, as described in the following paragraph.

4-159. During normal operation (in the frequency C function) U4 is originally disabled by a High logic level at U4 pin 14 (0 volts). When the counter is ready to make a measurement and it senses that an input signal is present via the "C ARM" line, the main gate opens. Pin 14 on U4 then goes "low" (to -600 mV) and the input signal passes through U4 (÷5) where it is translated to ECL levels. A 50-40% duty cycle (for sine wave inputs) signal is sent to the A4 Function Selector on "C" and "$\overline{C}$" bus lines, after the time base counts out, the main gate closes, U4 pin 14 goes high and U4 and U5 stop in their present states. Circuit U6 translates the information in U4–U5 to TTL level and it is shifted into a quad latch (U7) where it is stored for strobing into the display.

4-160. Circuit U10, Q1, Q2, and various resistors constitute a current source to properly bias U1 and U2. The circuit draws approximately 16 mA out of pin 3 on each IC and adjusts the current out of pin 6 between 28 and 56 mA until the voltage on pin 3 is approximately +600 to +900 mV on each IC.

4-161. Resistors R1, R2, R4, and R82 and U9A comprise the offset voltage adjustment circuit. This circuit also compensates for changes in input bias current into U1 to minimize drift in offset voltage.

4-162. HP INTERFACE BUS THEORY

4-163. The HP Interface Bus transfers data and commands between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel to the signal lines.

4-164. Eight of the lines (DIO1—DIO8) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines (DAV, NRFD, NDAC). The other five lines are for control of bus activity,

4-165. Devices connected to the bus may be talkers, listeners, or controllers. The controller dictates the role of each of the other devices by setting the ATN (attention) line low and sending

talk or listen addresses on the data lines (DIO1—DIO8). Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a PC board. While the ATN line is low, all devices must listen to the data lines. When the ATN line is high, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

4-166. Several listeners can be active simultaneously but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is low), all other talkers will be automatically unaddressed.

4-167. Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

4-168. The ATN line is one of the five control lines. When ATN is low, addresses and universal commands are transmitted on seven of the data lines using the ASCII (American Standard Code for Information Interchange) code. When ATN is high, any code of 8 bits or less understood by both talker and listener(s) may be used.

4-169. The other control lines are IFC, REN, SRQ, EOI. IFC (interface clear) places the interface system in a known quiescent state. REN (remote enable) is used with other coded messages to select either local or remote control of each device.

4-170. Any active device can set the SRQ (service request) line low. This indicates to the controller that some device on the bus wants attention, say a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

4-171. EOI (end or identify) is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines low, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

4-172. For a more detailed description of bus operation, refer to the manual entitled “Condensed Description of the Hewlett-Packard Interface Bus”, HP Part No. 59401-90030.

4-173. HP-IB A15 INTERFACE OPERATION

4-174. The 5328A HP-IB Interface is used to remotely program the 5328A and deliver the measurement results to the bus. Thus, the board operates both as a listener and as a talker.

4175. As a listener, the interface is capable of programming most of the controls in the mainframe and all programmable modules that may be installed. The HP-IB board contains storage circuits to control the mainframe remotely, and is set up to program the storage circuits in any programmable module.

4-176. As a talker, the interface is capable of outputting the measurement data in exponential format with a mantissa of nine digits (leading zeros are output as spaces) and an exponent of one digit. Overflow and signal information is also contained along with a carriage return (CR), linefeed (LF) termination ot make it compatible with the standard HP-IB serial data format.

4-177. In addition to being a talker and listener, the HP-IB Interface follows a set of HP-1 B commands. This includes complete service request capability, The ASCII codes used for addressing and for data are shown in Table 3-7. Address switch information is shown in Table 3-4. The program code set is shown in Table 3-5.

4-178. Overall Operation

4-179. The heart of the HP-IB Interface is a 256 state algorithmic state machine (ASM) controlled by a 256x16 ROM (U22) as shown in the block diagram. This state machine has two different format states determined by the format (F) bit from U22. One state (F=0) is an output mode state where the machine will proceed sequentially to the next state (address) after storing or outputting information. The other state (F=1) is a mode where the machine can either proceed to the next line or perform a conditional jump to a different line in the program. The decision as to which state is chosen is made on the basis of where the qualifier bit from U11A is low or high. Preset counters U14 and U23 provide presetting to a jump state when F=1 and the qualifier is low. These counters increment their count in all other cases. Altogether, there are 52 different bits that may be selected as the qualifier for a particular state.

4-180. Qualifier negate circuit U30C can invert the qualifier bit for any given state so that the machine can branch on the qualifier being low or being high. U7 is added for psuedo subroutine capability. In the output mode, the ASM goes through the same group of states once for every character being outputted on the bus. U7 is incremented every time so that the ASM can tell which character it is to output.

4-181. Bus Command Mode

4-182. In this mode (ATN low), the ASM accepts parallel bytes of information and decodes them into bus commands. This usually requires setting or clearing bits of storage in U19 or U26.

4–183. Listen Mode

8-184. In the listen mode, the listen qualifier of U26 must be low and ATN high. The interface will then accept 8-bit parallel bytes continuously. When receiving the ASCII characters P, Q, U, R, or T the counter will act upon the byte immediately (refer to programming in Section Ill). When receiving the letters F, G, A, B, C, D, or S the interface will then route any ASCII number or numbers following these letters into particular storage registers. These registers are U28, U33, and U34 along with any that are contained in any of the optional modules installed in the mainframe.

4-185. Talk Mode

4-186. The HP-IB Interface will go into the talk mode if the talk qualifier of U26 is low or the talk always switch is set to talk always and ATN high for both cases. There will be no output in normal operation unless a completed measurement is present and has not been outputted. The information to be put on the bus is latched into latches U15 and U24. These drive the high current buffers U5, U10, and U16, Counter U7 is used as a pointer for the ASM to recognize which character in the serial output string the interface is to output.

4-187. A15 Circuit Operation

4-188. The following paragraphs describe the circuit operation of the HP-IB Interface.

4-189. STATE COUNTERS. The state of the ASM ROM (current state and next state) is determined by State Counters U14 and U23. These counters from an 8-bit presettable binary counter, When pin 1 of U25 is low, the counters will always increment. When pin 1 of U25 is high, the counters will preset (jump to another state in the program) if the output of U30C is high. The preset address is supplied to the State Counters input from the ROM. The program is shown in the operational flowchart, *Figures* 5-4, 5-5, and 5-6. The output of U30C is determined by the “not” bit from the ROM (through U21E) and the output of the Qualifier FF U11A. The preprogrammed state of the “not” bit determines whether a high or low output of the qualifier FF will result in a jump in the program. (This is shown in the ASM Operational Flowchart, by

the use of the letter “N” in a decision diamond symbol.) The preset (jump) is synchronous and only occurs when pin 9 of U14 and U23 is low and when there is a rising edge at pin 2 of U14 and U23. FF U31A synchronizes the reset of the State Counters to occur at the proper time.

4-190. ASM OSCILLATOR. As shown in the ASM Oscillator Timing Diagram, Figure 4-70, the ASM oscillator circuit provides three separate phases of clock outputs. Schmitt trigger U18A is the fundamental oscillator element which uses hysteresis to develop oscillation, The output of U18A (through U13) strobes storage latches U11A and B, U15, U19, U24, U26, U28, U33, U31B, and U34. The output of U18A is also sent through a delay circuit consisting of resistor R14 and capacitor C4 into U18B to provide another phase of the clock output that determines the next state of the ASM. In addition, the output of U18A is sent through U30A to provide a third clock phase which is applied to U31A. The output of U31A resets the 8-bit State Counter synchronously at power up or when the IFC signal occurs. (Synchronous reset prevents loading the storage latches with erroneous data.) The IFC signal also resets U26 (ASM storage). The power up reset circuit U18C and U18D clears all storage elements.

4-191. BUS INTERFACE. The bus interface circuit consists of bus line termination resistors, data output drivers and data input buffers. Resistors R29 and R30 form the line termination networks, U4 is used to buffer the bus line inputs and U5, U10, and U16 are high current drivers that drive the bus lines output. The ATN signal is sent through U9A and U29D to ensure that the gates connected to bus lines DIO1—DIO7 and DAV do not output when ATN goes true. The DAO signal from U24(9) arms the DAC signal through U17B to ensure that DAC goes false within a few gate delays after ATN goes true. (1 n some cases, the DAC response from the ROM may be too slow.) After ATN is true, DAO is set to a “0” to allow normal operation of the DAC line.

4-192. END OF MEASUREMENT. When a measurement has been completed, FF U11B is set. This FF is clocked by the closing edge of the LMG signal. Diode CR2 and transistor Q3 keep U11B from going to the “l” state when LRES is low or HRD is high, (During these times the counter is being reset and noise appears on the LMG line which could trigger UIIB.)

4-193. QUALIFIER MULTIPLEXER. Five 8-to-1 multiplexer are connected to allow 36 lines to be multiplexed into 1 line. ASM ROM U22 controls multiplexer U3, U6, U8, and U32 to select individual line qualifiers and U12 to select one of these multiplexer. In addition, U12 checks the output of auxiliary State Counter U7, a 4-bit binary counter that allows the same sequence of states to be repeated up to 16 times. In the output algorithm, each state represents an output character. Qualifier FF U11A eliminates erroneous results by ensuring that the State Counters U14 and U23 are not clocked when a qualifier is changing states. This would cause a partial preset and partial increment of the State Counters,

4-194. ADDRESSING. Address Comparator U2 monitors the Data Input/Output (DIO) lines 2 through 5 and the address switch (S1) settings. When a comparison occurs between the state of these DIO lines and the address switch settings, U2 sends qualifier ADDR to multiplexer U8. The TALK ALWAYS section of the address switch provides a means of setting U6 so that interface is always addressed to talk.

4-195. DATA OUTPUT. The Data Output circuit outputs characters on the bus data lines. Storage circuit U24 transfers outputs from the ROM to DIO lines 5 through 7. U15 selects data from either the ROM or the 5328A data bus and transfers it to DIO1—DIO4. The state of the “not” bit from ROM U22(13) through U21E determines the selection made by U15. A displayed digit is selected from the 5328A, any other characters (decimal point, “E”, carriage return, exponent, linefeed, etc.) are selected from the ROM.

4-196. ASM STORAGE. The internal memory for the ASM operation is in ASM Storage circuits U19, U26, and U31B. There are 17 information bits that can be set or cleared by these circuits. This section also includes one-shot U1 which outputs a 2 ms pulse (LRST) to ensure reliable

operation of the state control circuit U4 on the motherboard. Diode CR3 ensures that LINH is low to inhibit the counter during the time that LRST is low.

4-197. STROBE ENABLE DECODER. Decoder U13 is a 4- to lo-line decoder used to strobe the various storage latches. Pins 1, 14, and 15 are used to select the device to be strobed and pin 2 is an enable which determines the width of the strobe pulse. The output of U25C disables U13 when the ASM is in the decision state mode. In the decision state mode, the format bit U22(17) goes high which disables U13.

4-198. REMOTE PROGRAM STORAGE. Storage circuits U28, U33, and U34 are used to program instrument functions. U28 stores Time Base codes in 3-bit bytes and U34 stores Function codes in 4-bit bytes. U33 stores 8 bits of information, one-bit at a time. The Sample Rate, Arming, Storage Off, and Decade Reset can be programmed by U33. In addition, U33(4,5, and 6) control the manner in which measurements are made and output to the bus. The inputs to the remote program storage circuits are the Module Data A, B, C, and D lines from DIO lines, 1,2,3, and 4, respectively.

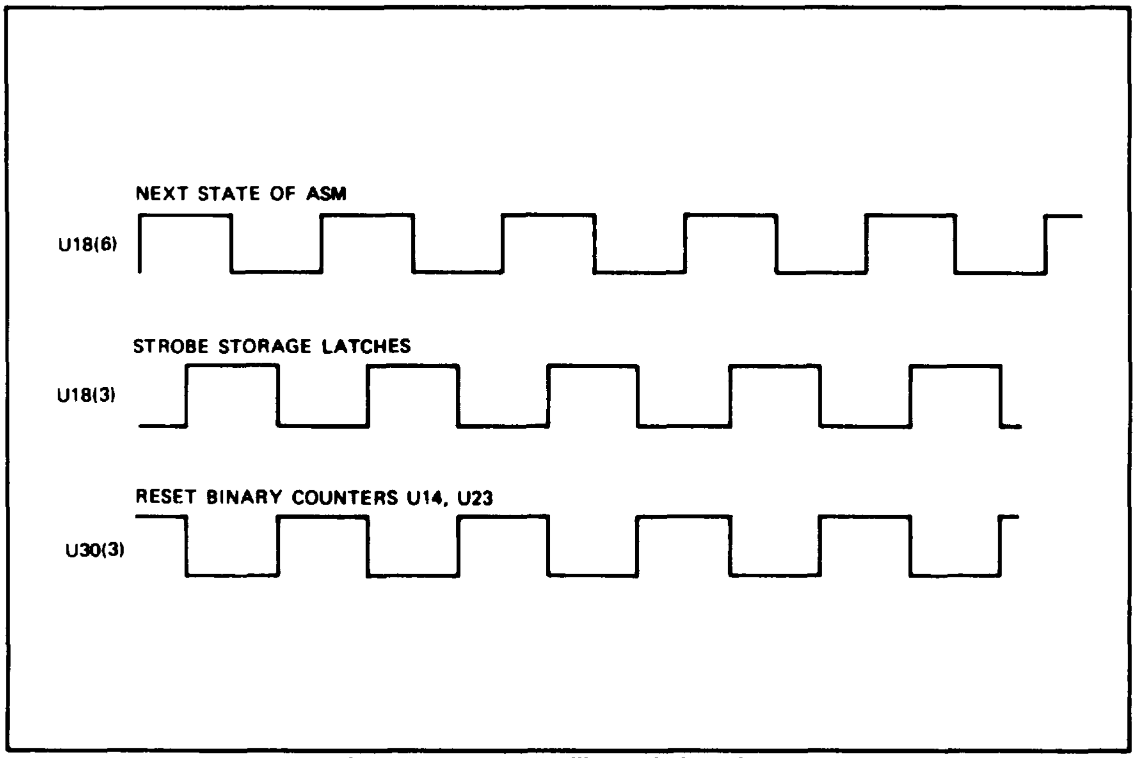


Figure 4-10. ASM Oscillator Timing Diagram

SECTION V
MAINTENANCE

5-1. INTRODUCTION

5–2. This section gives maintenance and service information. Included is a table of assemblies, recommended test equipment, a performance test, (which may be used to verify proper counter operations) and adjustments.

5-3. ASSEMBLY DESIGNATIONS

5-4. Table 5-1 lists the designations, name, and Hewlett-Packard part number of assemblies used in this instrument.

5-5. TEST EQUIPMENT

5-6. Test equipment recommended for maintaining and checking performance is listed in Table 5-2. Test equipment having equivalent characteristics may be substituted for the equipment listed. Required test equipment is listed in Appendix D, Maintenance Allocation.

5-7. ASSEMBLY CONNECTION IDENTIFICATION

5-8. Throughout the manual, connections to printed-circuit assemblies are referred to in abbreviated form. For example, connection to A4 pin 10 is A4(10).

Table 5-1. 5328A Assembly Identification

"A" Number	Description	HP Part No.
A1	Main (Motherboard)	05328–60028
A2	Power Supply	05328–60035
A3	Oscillator Support (Holds 10544A Oscillator)	05328–60027
A3A1	Oscillator 10544A	10544–60011
A4	Function Selector	05328–60005
A5	Not used	
A6	Not used	
A7	Not used	
A8	"C" Channel Input	05328–60032
A9	Not used	
A10	Synchronizer	05328–60020
A11	Digital-to-Analog Converter	05328–60023
A12	"A–B" Channel Input	05328–60031
A13	Not used	
A14	Not used	
A15	HP-IB Interface	05328–60019
A16	Display	05328–60026
A17	Not used	
A18	Not used	
A19	Switch (Attenuator)	05328–60030

Table 5-2. Recommended Test Equipment

Instrument Type	Required Characteristics	Recommended Type
Frequency Standard	1 MHz Output	HP 107AR
Oscilloscope Vertical Plug-In Time Base Plug-In 1 GHz Sampler	50 MHz Bandwidth 50 mV/cm Sensitivity 50 MHz Bandwidth 1 GHz Bandwidth	HP 180A HP 1801A HP 1820A HP 1810A
Test Oscillator	10 Hz to 10 MHz at 5V p-p	HP 651B
VHF Signal Generator	10 MHz to 480 MHz	HP 608E
Frequency Counter	10 to 80 MHz Frequency Measurements	HP 5381A
Digital Multimeter	10V Range .01% Accuracy	HP 3490
DC Voltmeter	0 to 200V dc, 1% Accuracy	HP 970A
AC VTVM	0 to 250V ac	HP 400F
RF Voltmeter	1 mV to 3V	HP 3406A
Logic Probe	Logic State Test	HP 10525T
Logic Pulser	State Activator	HP 10526T
Logic Comparator	IC Test	HP 10529A
Calculator	HP-IB Compatible	HP 9830A or 9820A
HP-IB Calculator Interface	Connects 9830A to HP-IB	HP 59405A, Option 030
Printer	Compatible with 9830A	HP 9866A
Pulser Generator	0.5 Hz to 25 MHz at 1V	HP 8008A
DC Power Supply	0—10V Stable to ±1 mV	HP 6213A
RMS Voltmeter	RMS ac Voltage 0—10V Range	HP 3400A

5-9. PREVENTIVE MAINTENANCE

5-10. Preventive maintenance consists of periodic inspection, cleaning, performance checks, and oscillator calibration. Table 5-3 lists the recommended schedule of preventive maintenance routines.

Table 5-3. Preventive *Maintenance*

Routine	Schedule
Inspection	Weekly
Cleaning	Monthly
Performance Test	As required
Oscillator Calibration	Quarterly

5-11. Inspection

5-12. The 5328A should be inspected for indications of mechanical and electrical defects. Electronic components that show signs of overheating, leakage, frayed insulation, and other signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Mechanical parts should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

5-13. Cleaning

5-14. The instrument should be kept free of dust, moisture, grease, and foreign matter to ensure trouble-free operation. A dry clean cloth, a soft bristled brush, or a cloth saturated with cleaning compound may be used.

WARNING

100/120/220/240 VAC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.

5-15. Performance Test

5-16. GENERAL. The performance test (Table 5-4) and test card sheets that follow the test can be used to verify and record proper operation of all circuits of the counter and may also be used:

a. As part of an incoming inspection check of instrument specifications.

b. Periodically, for instruments used in systems where maximum reliability is important.

c. As part of a procedure to locate defective circuits.

d. After any repairs or adjustments and before returning instrument to regular service.

e. As a permanent record of instrument maintenance performed, because the test record pages may be removed.

5-17. REPAIR

5-18. Printed Circuit Component Replacement

5-19. Component lead holes in the circuit boards have plated-through walls to ensure good electrical contact between conductors on opposite sides of the board. To prevent damage to the plating and the replacement component, apply heat sparingly, and work carefully.

5-20. Replacing Integrated Circuits

5-21. Following are two recommended methods of replacing integrated circuits:

a. SOLDER GOBBLER. This is the best method. Solder is removed from board by a soldering iron with a hollow tip connected to a vacuum source,

b. CLIP-OUT. This method should be used as a last resort only. Clip the leads as close to the base as possible. With a soldering iron and long nose pliers, carefully remove the wires from each hole. Then clean the holes.

Table 5-4. *Performance Test*

1. SENSITIVITY - Channel A

Specification:

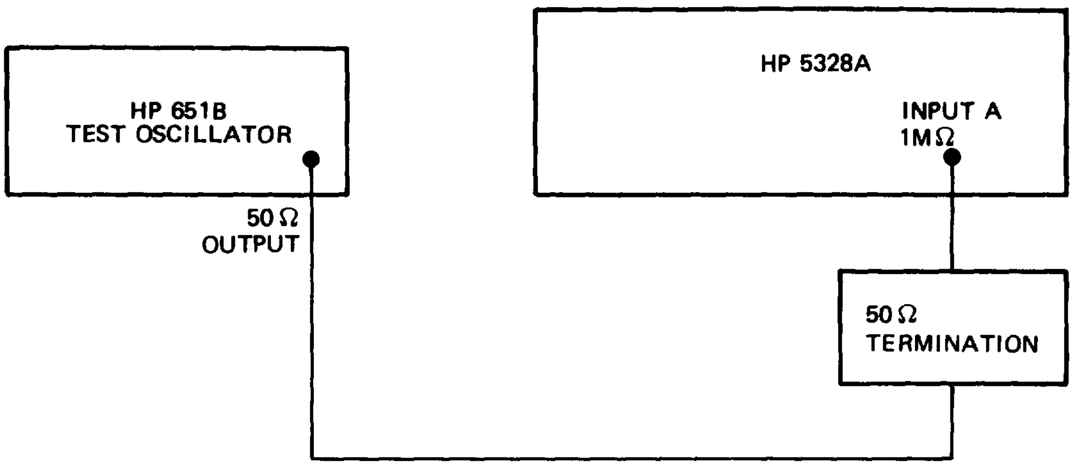
15 mV rms, 0-35 MHz (dc coupled)
20 Hz-35 MHz (ac coupled)

50 mV rms, 35 MHz-100 MHz

Description: A signal generator with calibrated output is set to the specified 5328 signal sensitivity level and varied over the specified frequency range. The counter must display the correct frequency.

a. 10 Hz to 10 MHz

Setup:



(1) DC coupled 10 Hz to 10 MHz

- Set the 5328A to FREQ A, 1 Hz RESOLUTION, SAMPLE RATE fully ccw, Level A to PRESET, DC COUPLING, ATTEN X1, SEP. Rear panel ARM switch should be set to OFF.
- Set the 651B for 15 mV rms. Vary the 651B's frequency from 10 Hz to 10 MHz and verify that the 5328A displays the proper frequency. Adjust the 5328 LEVEL A control as necessary to achieve a stable display. Mark results on performance test record at the end of these procedures.

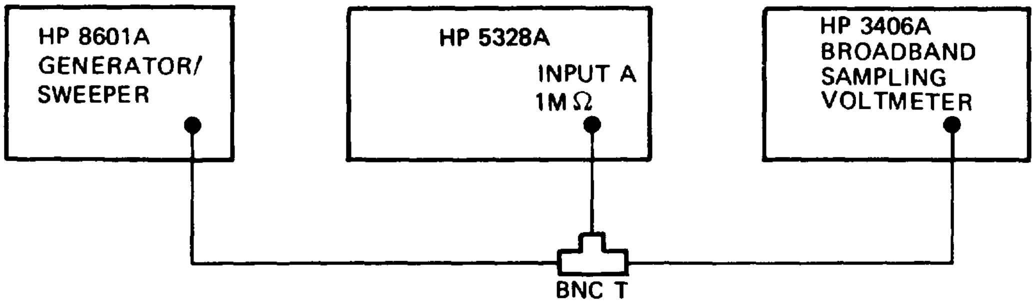
(2) AC coupled 20 Hz to 10MHz

- Set the 5328 to AC coupling.
- Set the 651B for 15 mV rms. Vary the 561B's frequency from 20 Hz to 10 MHz and verify that the counter displays the proper frequency. Adjust the 5328 LEVEL A control as necessary to achieve a stable display. Mark results on performance test record at the end of these procedures.

Table 5-4. Performance Test (Continued)

b. 10 MHz to 100 MHz

Setup:



(1) DC coupled 10 MHz to 100 MHz

- Set the 5328A to DC COUPLING.
- Set the "8601A for an output level of 15 mV rms as measured on the 3436A RF voltmeter. Vary the 6601A's frequency from 10 MHz to 35 MHz and verify that the counter displays correct frequency readings. Increase the 8601A output level to 50 mV rms and vary the frequency from 35 MHz to 100 MHz. Verify that the counter displays correct frequency readings. Adjust 5328A LEVEL A control as necessary to obtain stable display. Mark results on performance test record.

(2) AC coupled 10 MHz to 100 MHz

- Set the 5328A to AC coupling.
- Set the 8601A for an output level of 15 mV rms and repeat part 2 of step (1.) above.

2. SENSITIVITY - Channel B

Specification:

15 mV rms,0-35MHz (dc coupled)
20 Hz-35 MHz (ac coupled)

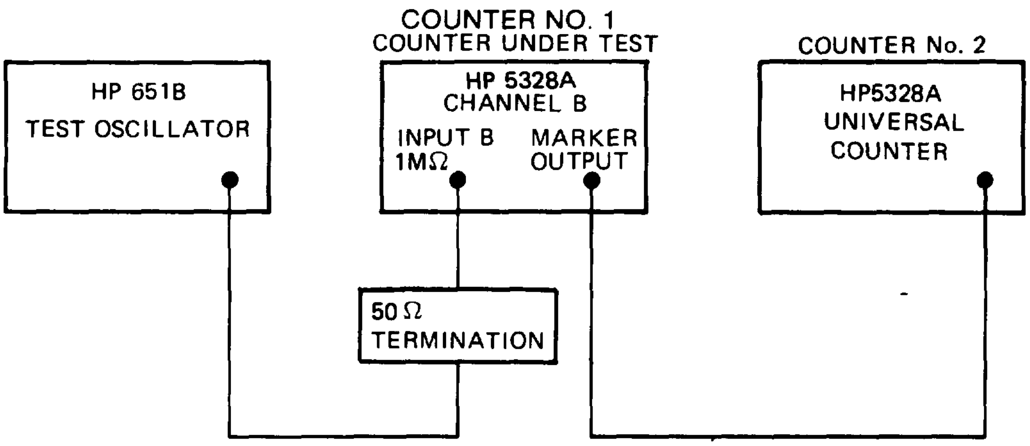
50 mV rms, 35 MHz-100MHz

Description: A generator with calibrated output drives the B channel of the 5328A under test. The frequency of the B channel MARKER OUTPUT is measured by a second frequency counter. The generator is set to the specified 5328A signal sensitivity level and varied over the specified frequency range. The second counter must display the correct frequency. Adjustments of the 5328A LEVEL B control may be necessary to achieve a stable count.

Table 5-4. Performance Test (Continued)

a. 10 Hz to 10 MHz

Setup:



(1) DC coupled 10 Hz to 10 MHz

- Set counter No. 1 (HP 5328A) to SEP, LEVEL B to PRESET, ATTEN X1 (B channel), DC coupling (B channel).

- Set the 651B to 15 mV rms. Vary the 6516's frequency from 10 Hz to 10 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

(2) AC coupled 20 Hz to 10 MHz

- Set Counter No. 1 (HP 5328A) to AC coupling (B channel).

- With the 651B set to 15 mV rms, vary the frequency from 20 Hz to 10 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

b. 10 MHz to 100 MHz

Setup:

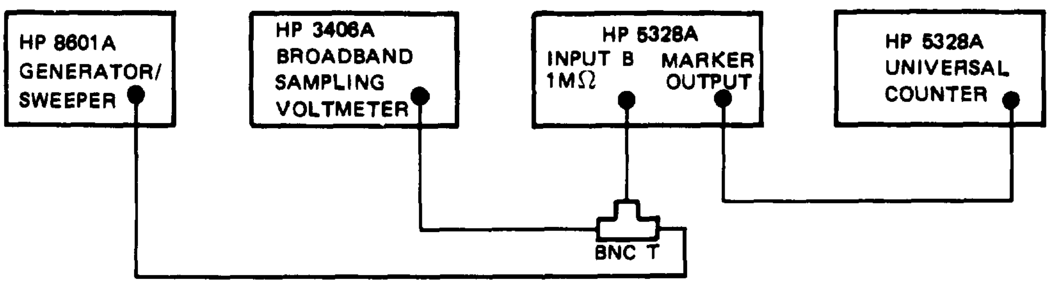


Table 5-4. *Performance Test (Continued)*

(1) DC coupled 10 MHz to 100 MHz

- Set Counter No. 1 (HP 5328A] to DC coupling (B channel).

- Set the 8601A for an output level of 15 mV rms as measured on the 3406A RF voltmeter. Vary the 8601A's frequency from 10 MHz to 35 MHz and verify that the 5328A Channel B MARKER OUTPUT is the correct frequency as read by counter No. 2. Increase the 8601A output level to 50 mV rms and vary the frequency from 35 MHz to 100 MHz. Counter No. 2 must continue displaying the correct input frequency. Adjust the 5328A LEVEL B control as necessary to achieve a stable display. Mark results on performance test record.

(2) AC coupled 10 MHz to 100 MHz

- Set Counter No. 1 (HP 5328A) to DC coupling (B channel).

- Set the 8601A for an output level of 15 mV and repeat part 2 of step (1) above.

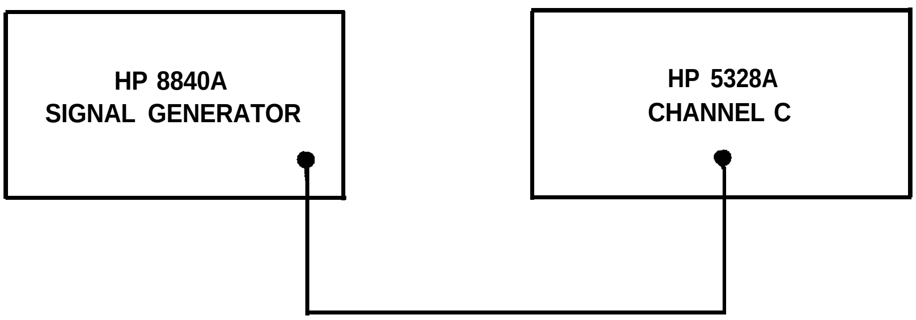
3. SENSITIVITY-Channel C

Specification:

15 mV rms, 30 MHz-500MHz

Description: A signal generator covering the frequency range from 30 MHz to 500 MHz is set to the specified channel C 5328A signal sensitivity level and varied over the specified frequency range. The counter must display the correct frequency.

Setup:



- Set the 5328A to FREQ C, 1 kHz, 10^3 Resolution, SAMPLE RATE midrange.

- Set the signal generator for an output of 15 mV rms (-24 dBm for 50Ω). Vary the frequency from 30 MHz to 500 MHz and verify that the counter displays the proper frequency.

Table 5-4. Performance Test *(Continued)*

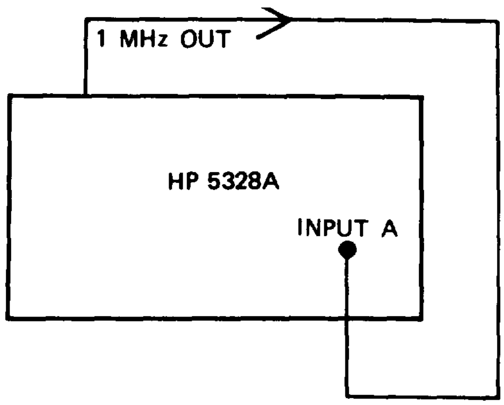
4. PERIOD AND PERIOD AVERAGE

Specification:

PER A - counter will measure periods of signals to 10 MHz with resolutions from 10 ns to 0.1s in decade steps.

PER AVG A - counter will measure periods of signals to 10 MHz with resolutions from 100 ns to 0.01 ps in decade steps. The number of periods over which the period average measurement is made can be selected by the FREQ RESOLUTION, N switch.

Description: The 1 MHz time base output from the rear panel of the 5328A drives the A channel input of the counter.



- Set 5328A Function switch to PER A; Freq Resolution, N switch to 1 MHz, 1; Level A to PRESET; AC coupling; X10 ATTEN; SEP. Verify that the counter displays 1.0µsec. Mark results on performance test record.
- Set the 5328A Function switch to PER AVG A and the Freq Resolution, N switch to 1 Hz, 10^6. Verify that the counter displays approximately 999,9XXXX nsec with 0.1 psec resolution. Mark results on performance test record.

5. RATIO B/A, or C/A

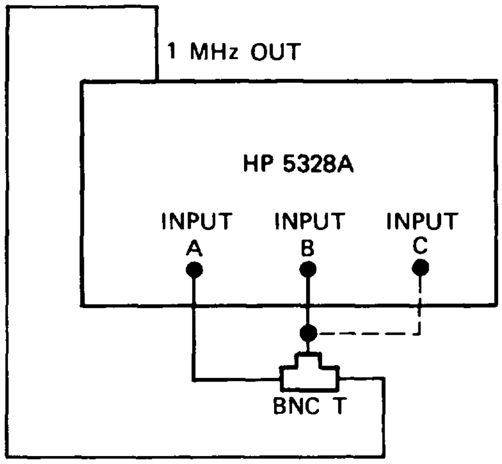
Specification:

RATIO B/A, RATIO C/A-Counter will measure the ratio of the frequency at B (0 to 100 MHz) or C (30 to 500 MHz) to the frequency at A (0 to 10 MHz) for N counts of A.

Description: The 1 MHz time base output from the rear panel of the 5328A drives the A, B or C input channels of the counter.

Table 5-4. Performance Test (Continued)

Setup:



- Set the 5328A Function switch to RATlO B/A: Freq Resolution. N switch to 1 kHz, 10^3; Level A and B to PRESET; AC coupling on both channels; X10 ATTEN on both channels; COM A. Verify that the counter displays 1.000. Mark results on performance test record.
- Set the 5328A Function switch to RATlO C/A; SEP. Disconnect the channel B input and reconnect it to channel C. Verify that the counter displays 1.000.

6. TIME INTERVAL AND TIME INTERVAL AVERAGE

Specification:

T.I. A-B - counter measures time intervals (100 ns to 10^8 see) between a start signal at the channel A input and a stop signal at the channel B input.

T.I. AVG A-B - counter measures time intervals (0.1 ns to 10 see) between a start signal at the channel A input and a stop signal at the channel B input. The number of time intervals over which the time interval average measurement is made can be selected by the FREQ RESOLUTION, N switch.

Description: A 1 MHz signal drives the A and B channel inputs of the 5328A counter.

Setup:

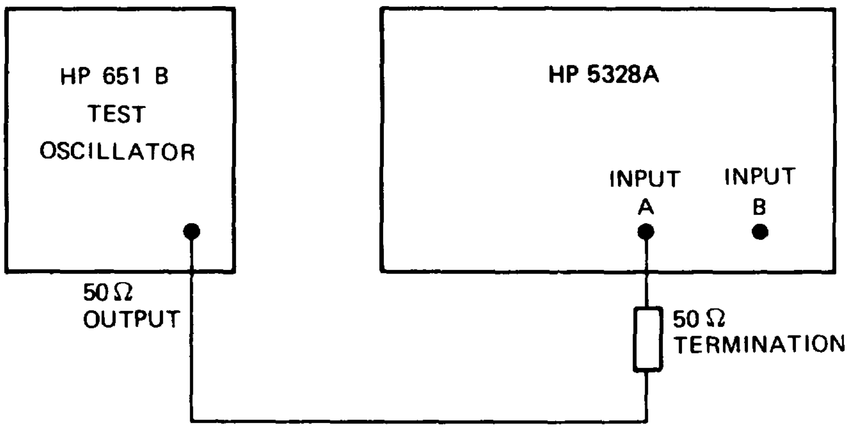
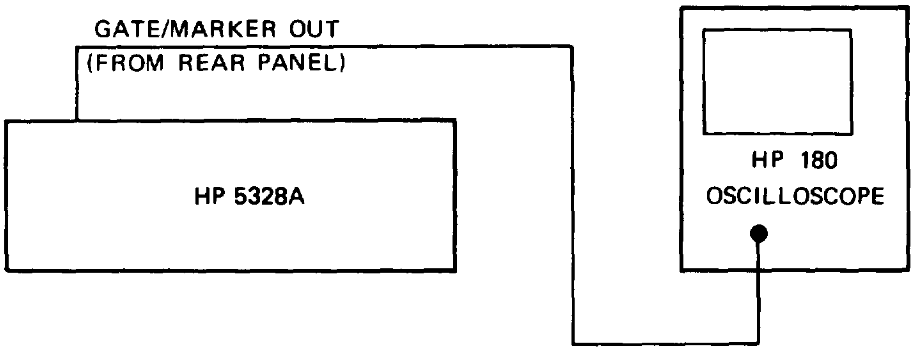


Table 5-4. Performance Test *(Continued)*

- Set the 651B to 1.0 MHz and 500 mV rms.
- Set the 5328A Function switch to T.I. A-B; Freq Resolution, N switch to 1 MHz, 1; Level A and B to PRESET; AC coupling on both channels, X1 ATTEN on both channels, COM A.
- Set the Channel A SLOPE to (+) and the Channel B SLOPE to (–). Verify that the counter displays 0.5 µs ±0.25 µs. Mark results on performance test record.
- Set 5328A Function switch to T.I. AVG A→B and Freq Resolution, N switch to 1 Hz, 10^6. Verify that the counter displays 500.XXXX ns. Mark results on performance test record.
- Change Channel A SLOPE to (-) and Channel B SLOPE to (+). Verify that the counter displays 500.XXXX ns. Mark results on performance test record.

7. GATE/MARKER OUT AND SAMPLE RATE

Setup:

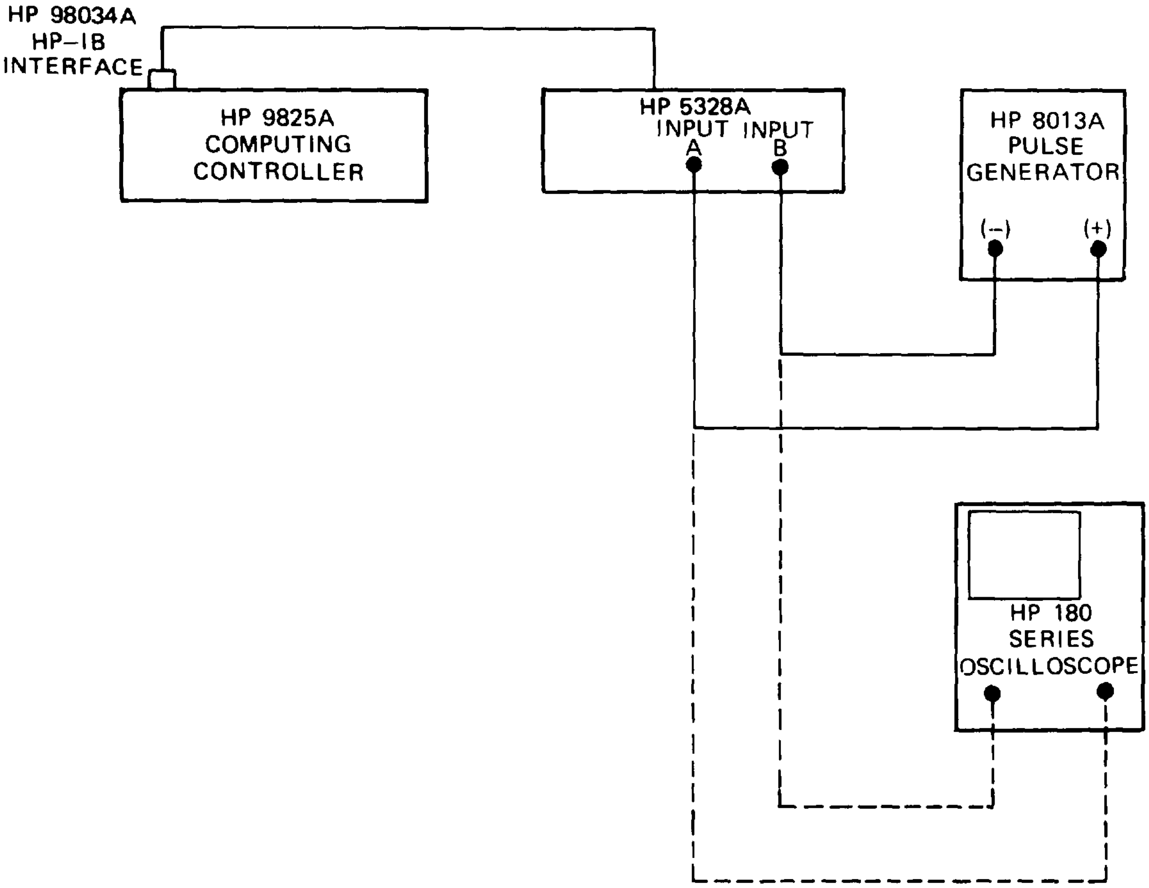


- Set the 5328A to CHECK, 1 kHz, 10^3 Resolution.
- Observe the GATE/MARKER OUT signal from the counter. Vary the SAMPLE RATE control to full ccw. The GATE/MARKER OUT signal must be greater than 2.4 Vdc and the sample delay (time during which GATE/MARKER OUT is Low) must be less than 2 msec. Mark results on performance test record.

Table 5-4. Performance Test (Continued)

8. REMOTE PROGRAMMING TEST

Setup:



- Set the 5328A rear panel address switches as follows:

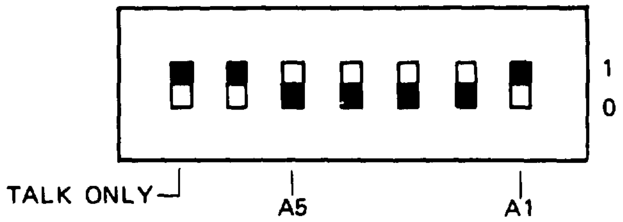
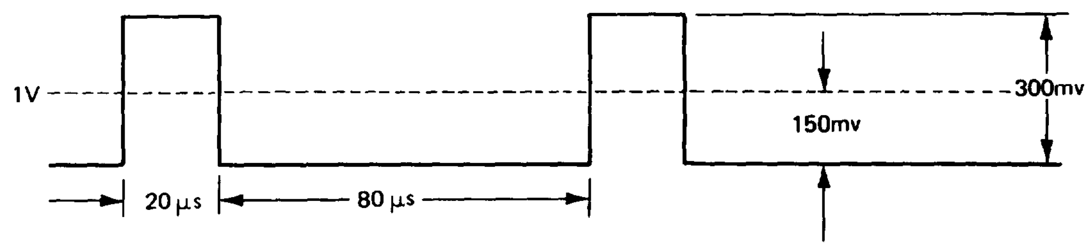
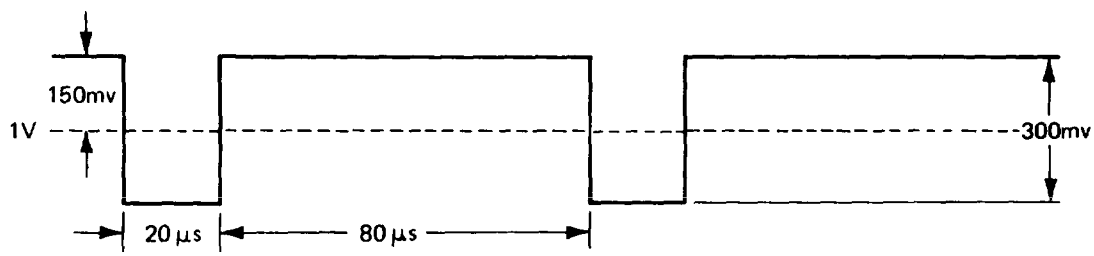


Table 5-4. Performance Test (Continued)

- Set the pulse generator for the following output:



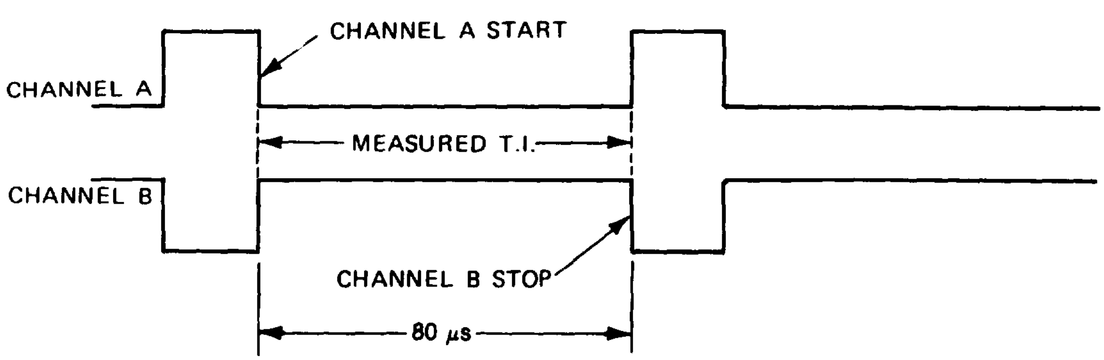


a. (-) SLOPE TEST

Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A57+000*B57+000*R"

Counter should display 20 µs ±10 µs. Mark results on performance test record.



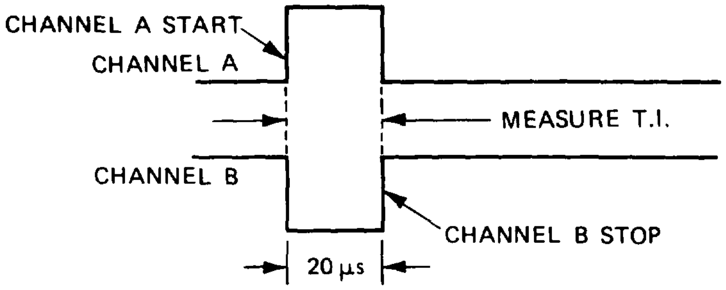
b. (+) SLOPE TEST

- Press RESET button on HP 5328A. Set Channels A and B slope switches to (-).
- Execute the following from the 9825A keyboard.

wrt 701, "PF8G1S13A7+000*B7+000*R"

Table 5-4. Performance Test (Continued)

- Counter should display 20 µs ±10 µs. Mark results on performance test record.



c. AC/DC TEST

- Press RESET button on 5328A and set both channels A and B to AC coupling.
- Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A37+000*B37+000*R"

- Counter should display 0. µs and the GATE light should be off. Both A and B channel trigger lights should be lighted (but NOT blinking). Mark results on performance test record,

d. SEP/COM A TEST

- Press RESET on 5328A.
- Execute the following from the 9825A keyboard:

wrt 701, "PF8G1S13A79+000*B7+000*R"

- Counter should display 0. µs and the GATE light should be flashing. Both A and B channel trigger lights should be blinking. Mark results on performance test record.

e. INVERT TEST

- Execute the following from the 9825A keyboard:

- Counter should display 80. µs ±40 µs.
- Execute:

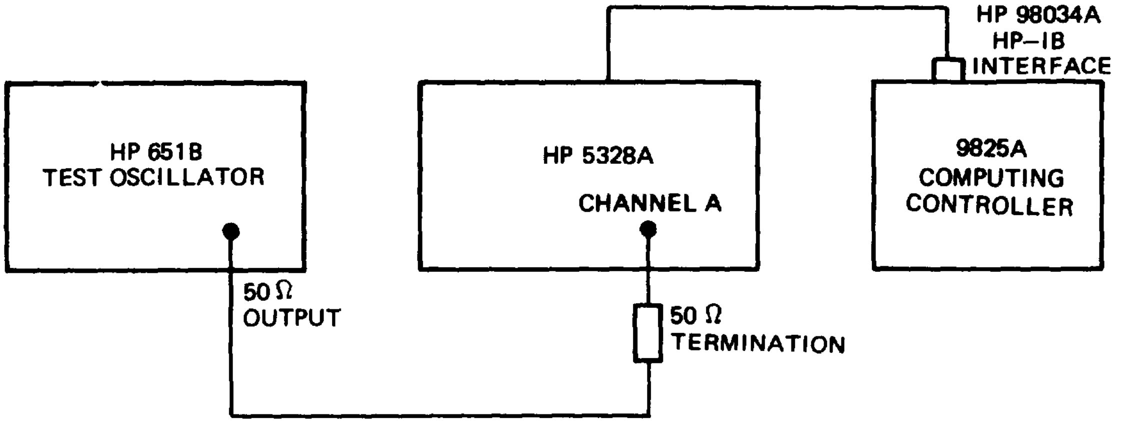
wrt 701, "B9R"

- Counter should display 20. µs ±10 µs. Mark results on performance test record.

Table 5-4. Performance Test (Continued)

f. ATTEN X1, X10, X100 TEST

Setup:



- Set the 651B to 1 kHz at an output level of 25 mV rms.

(1) ATTEN X1 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A379+000*B37+000*R"

- Observe that both channel A and B trigger lights are blinking.

(2) ATTEN X10 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A3+000*B3+000*R"

- Observe that both channel A and B trigger lights are off. Mark results on performance test record.

(3) ATTEN X100 TEST

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G5S13A319+000*B31+000*R"

- Observe that both channel A and B trigger lights are off. Mark results on performance test record.

Table 5-4. Performance Test (Continued)

9. REMOTE TRIGGER LEVEL TEST

Setup:

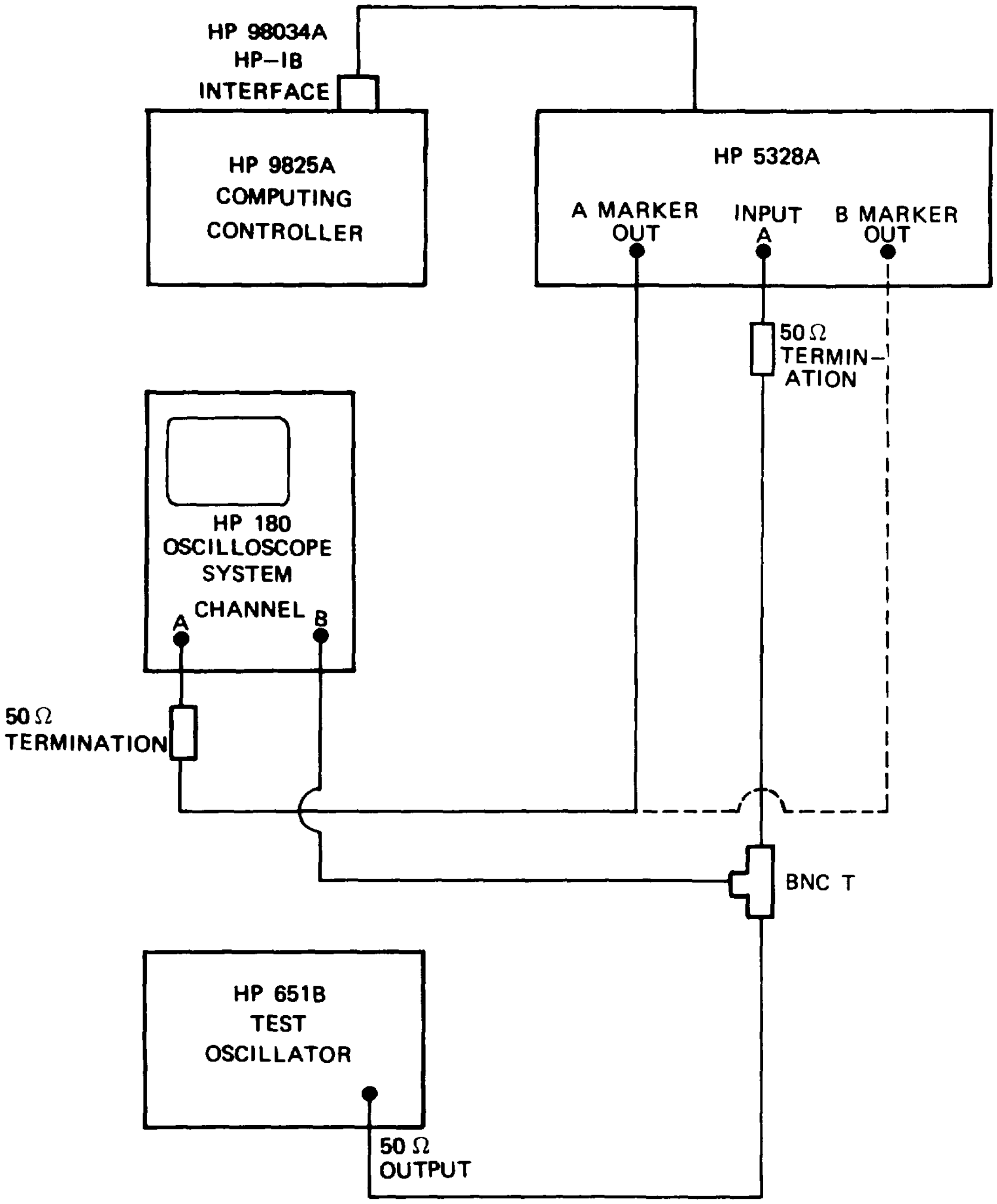
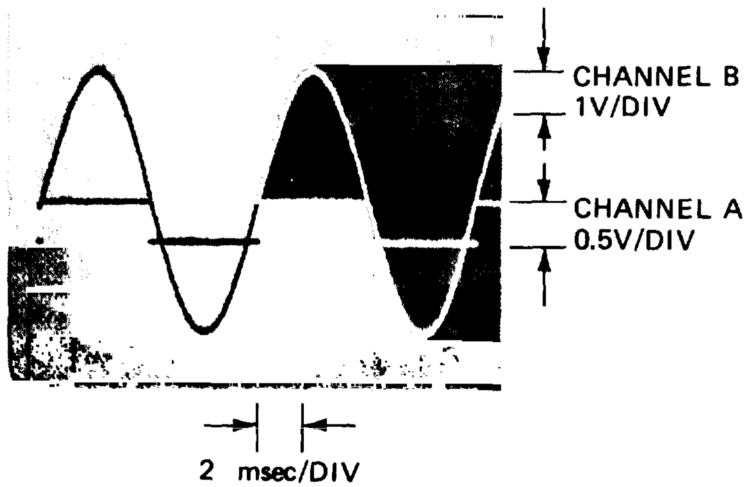


Table 5-4. Performance Test [Continued)

- Set channels A and B of the 5328A to DC coupling, COM A, X1 ATTEN, and FREQ A.
- Set the 6516 Test Oscillator for an output of 100 Hz at 6 volts peak-to-peak. Center the signal on the oscilloscope B channel display.
- Execute the following from the 9825A keyboard:

wrt 701, “PF4G6S13A379+000*B37+000*R”

- Adjust the display of the A channel marker output (on channel A of the oscilloscope) such that the top of marker waveform just barely intersects the positive slope and negative slope of the 100 Hz sine wave. Verify that this occurs at 0 volts on the 100 Hz sine wave.

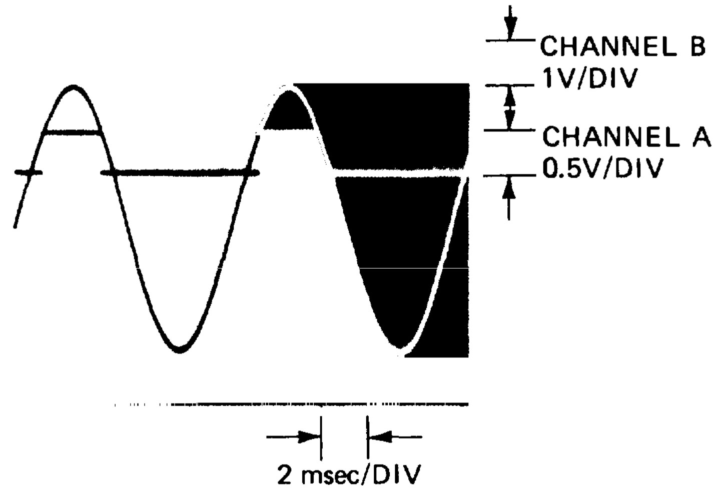


- Connect the counter’s B Marker Output to the A channel of the oscilloscope. Verify that the top of the marker intersects the 100 Hz sinewave at 0 volts.
- Execute the following from the 9825A keyboard:

wrt 701, “PF4G6S13A379+200*B37+200*R”

- Adjust the display of the B channel marker output such that the top of the marker just barely intersects both positive and negative slopes of the 100 Hz waveform. Verify that this occurs at +2 volts on the 100 Hz waveform as shown.

Table 5-4. Performance Test (Continued]

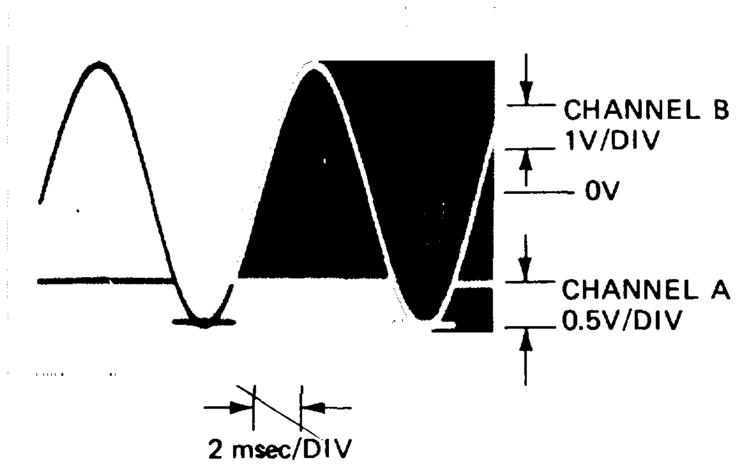


- Connect the 5328A A MARKER output to the A channel of the oscilloscope. Adjust the position of the A MARKER as described above and verify that it intersects the 100 Hz sinewave at +2 volts.

- Execute the following from the 9825A keyboard:

wrt 701, "PF4G6S13A379-200*B37-200*R"

- Adjust the display of the A channel marker output such that the top of the waveform just barely intersects both positive and negative slopes of the 100 Hz waveform. Verify that this occurs at -2 volts on the 100 Hz waveform.



Connect the 5328A B marker output to the A channel of the oscilloscope. Adjust the position of the B marker as described and verify that it intersects the 100 Hz waveform at -2 volts.

- Mark results on performance test record.

PERFORMANCE CHECK TEST CARD

5328A ____________________ Date ____________________

TEST	DESCRIPTION	RESULTS	
		PASS	FAIL
1	a. Sensitivity, Channel A		
	(1) 10 Hz-10 MHz, dc	______	______
	(2) 20 Hz-10 MHz, ac	______	______
	b. Sensitivity, Channel A		
	(1) 10 MHz-100 MHz, dc	______	______
	(2) 10 MHz-100 MHz, ac	______	______
2	a. Sensitivity, Channel A		
	(1) 10 Hz-10 MHz, dc	______	______
	(2) 20 Hz-10 MHz, ac	______	______
	b. Sensitivity, Channel B		
	(1) 10 MHz-100 MHz, dc	______	______
	(2) 10 MHz-100 MHz, ac	______	______
3	Sensitivity, Channel C		
	30 MHz-500 MHz	______	______
4	period and period Average		
	1.0 µsec display	______	______
	Approximately 999.9XXX nsec display with 0.1 psec resolution	______	______

PERFORMANCE CHECK TEST CARD

5328A ______________________ Date ______________________

TEST	DESCRIPTION	RESULTS	
		PASS	FAIL
5	RATIO B/A		
	1.000 display	________	________
	RATIO C/A		
	1.000 display	________	________
6	TIME INTERVAL AND TIME INTERVAL AVERAGE		
	TI A-B -0.5 µsec display	________	________
	TI AVG A-B, (+) to (-), 500.XXXX nsec display	________	________
	TI AVG A-B, (-) to (+), 500.XXXX nsec display	________	________
7	GATE/MARKER OUT AND SAMPLE RATE	________	________
8	REMOTE PROGRAMMING		
	a. (-) SLOPE TEST	________	________
	b. (+) SLOPE TEST	________	________
	c. AC/DC TEST	________	________
	d. SEP/COM A TEST	________	________
	e. INVERT TEST	________	________
	f. ATTEN TEST		
	(1) ATTEN X1 Test	________	________
	(2) ATTEN X10 Test	________	________
	(3) ATTEN X100 Test	________	________
	g. Trigger Level Test	________	________

5-22. ADJUSTMENTS

5-23. Adjustment procedures are provided for the oscillator and for the time interval unit (sensitivity). The adjustments should not be done unless:

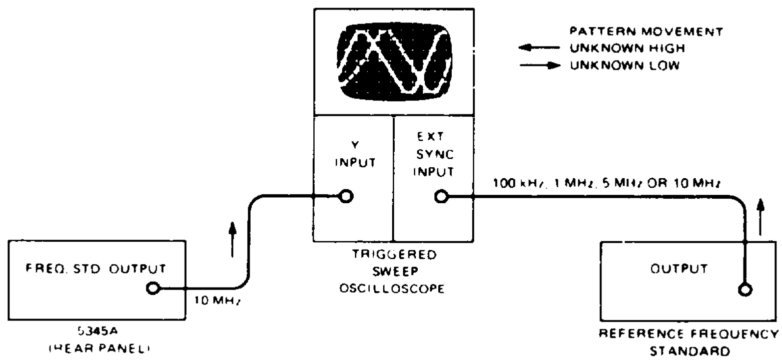
a. A trouble has been repaired which would affect these values.

b. The instrument does not meet all specifications while performing the check in Table 5-4 (Performance Test), or during periodic calibration.

5-24. OSCILLATOR ADJUSTMENT. Periodically, the oscillator should be checked against a house standard. When adjustment is required, use the oscilloscope method shown in *Figure* 5–2. Using the appropriate sweep speed, adjust the oscillator until the movement of the pattern is stopped or nearly stopped.

NOTE

When adjusting the 5328A oscillator, adjust FREQ ADJ on the 10544A crystal oscillator unit, and the fine tuning adjustment A3R14.



CALIBRATION

MOVEMENT	SWEEP SPEED			NOTES
	1μSEC CM	0.1μSEC CM	0.01μ SEC/CM	
1 CM/SEC	1×10^{-6}	1×10^{-7}	1×10^{-8}	TIME SCOPE TRACE MOVEMENT WITH SECOND HAND OF WATCH OR CLOCK
1 CM/10 SEC	1×10^{-7}	1×10^{-8}	1×10^{-9}	
1 CM/100 SEC	1×10^{-8}	1×10^{-9}	1×10^{-10}	

Figure 5-1. 10 MHz Oscillator Frequency Check

5-25. Sensitivity Adjustments

1. Adjust the channels A and B sensitivity as follows:

   a. Remove top cover of 5328A to gain access to variable resistors R28 and R26 on the A12 Amplifier Assembly (see location photo in Section VIII),

   b. Set 5328A front panel controls as follows:

FUNCTION .... FREQ A
RESOLUTION .... 10^5, 10 Hz
SLOPE (A) ....+
AC/DC (A) .... DC
ATTEN (A) 1
LEVEL (A) .... PRESET
SEP-COM A .... SEP
SAMPLE RATE .... MIDRANGE

c. Set 5328A rear panel control as follows:

ARM . . . . OFF

d. Connect HP 608E Signal Generator (or equivalent) to INPUT A. Set signal generator to 35 MHz at 50 mV rms (140 mV p-p).

e. Slowly decrease the signal generators output level to 15 mV rms (42 mV p-p), while adjusting variable resistor R26, to obtain a stable correct display, on the counter.

f. To set Channel B sensitivity change 5328A front panel controls as follows:

FUNCTION . . . . RATIO B/A
RESOLUTION . . . . 10^3 10 kHz
SEP-COM A . . . . SEP
LEVEL B . . . . PRESET

g. With HP 651B Test Oscillator (set to 10 MHz at 100 mV rms) connected to INPUT A, connect a second signal generator (set to 40 MHz at 50 mV rms) to iNPUT B.

h. Repeat step e adjusting variable resistor R28 instead of R26.

2. Channel C Sensitivity adjustments:

a. Remove the top cover from the 5328A.

b. Set signal to 100 MHz and reduce level until no stable reading in counter display. Adjust A8R82 for stable reading.

c. Repeat step b. until best sensitivity is obtained.

d. Repeat step b. to ensure that the counter still meets the requirement.

3. High Frequency Offset adjustments:

a. Remove top cover.

b. Set signal generator to 500 MHz and reduce signal level until display reading is no longer stable. Adjust A8R85 until display is stable.

c. Repeat step b. until best balance is obtained.

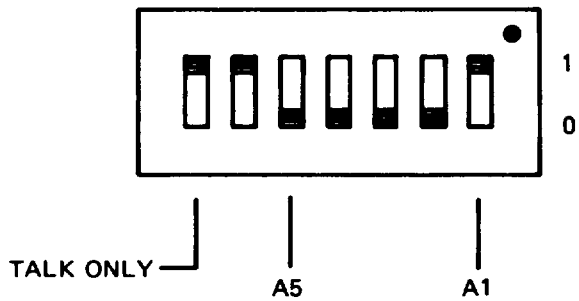
4. D-to-A Converter Adjustment procedure:

The following adjustment procedure adjusts the All D-to-A Converter outputs for accurate programmed trigger levels. Measuring the DAC outputs with a DVM is NOT an equivalent procedure. Since the gain through the 5328A input amplifiers is not exactly equal to 1.00, the signal arriving at the A12U4 comparator is not identical to the signal at the counter's input. As an example, assume the input amplifier gain is 0.95. Further assume an input signal which goes from 0 volts to 1.0 volt and it is desired to trigger at the 1.0 volt level. Since the signal arriving at A12U4 goes from 0 volts to 0.95 volts (due to the gain of 0.95), the trigger level specified by the DAC to A12U4 must be 0.95 volts. Triggering at 0.95 volts on the A12U4 input signal is the same as triggering at the 1.0 volt level on the original signal. The procedure described in the following takes into account the fact that the input amplifier gain is less than 1.0.

The procedure offsets an input signal to the 5328A by 0, +2, and -2 volts and programs the A and B channel trigger levels for 0, +2, and -2 volts respectively. For each offset, adjustments are made by observing the A (and B) channel marker outputs and adjusting for a 50% duty cycle. A 50% duty cycle indicates that the programmed trigger level (which is the center of the hysteresis band) is exactly equal to the dc offset at the signal input to the A12U4 comparator.

It is very important that the DAC adjustments be performed after the A and B channels sensitivity adjustment. In this adjustment, follow the procedure outlined on page 12 of the Option 041 Manual but adjust for optimum sensitivity by continuing to decrease the signal generator level below 25 mV rms and adjusting the A12R26, R28 for stable counter displays.

a. Set up the equipment as in Figure 5-2. Set the rear panel address switches on the 5328A to:



Set the 651B test oscillator to 20kHz at a level of 25 mV rms (70mV p-p). Set the 180A oscilloscope A channel for ac coupling and 50 mV per division. Verify that the 20 kHz signal into the counter is 70 mV p-p.

b. Disconnect the dc supply for a 0.0-volt dc offset on the input signal. Execute from the keyboard of the 9825A the following:

wrt 7Ø1, "PF4G5S1S3A379+000*B37+000*R"

Monitoring the 5328A Marker A output on the oscilloscope, adjust A11R21 for a 50% duty cycle in the Marker A signal as shown:

c. Connect the 5328A B Marker output to the B channel of the oscilloscope. Adjust A11R20 for a 50% duty cycle in the Marker B output signal. (The counter has been programmed for COMA.)

d. Connect power supply as in the figure and adjust for a dc level of 2.00 volts (±2 mV) as read on the DVM.

e. Execute the following from the keyboard of the 9825A:

wrt 7Ø1, "PF4G5S1S3A379+200*B37+200*R"

(press RECALL on 9825A and simply change DAC voltages as required.)

Adjust A11R18 for a 50% duty cycle on the 5328A B Marker output signal.

Connect the 5328A marker output signal to channel B of the oscilloscope. Adjust A11R24 for a 50% duty cycle on the A Marker output signal.

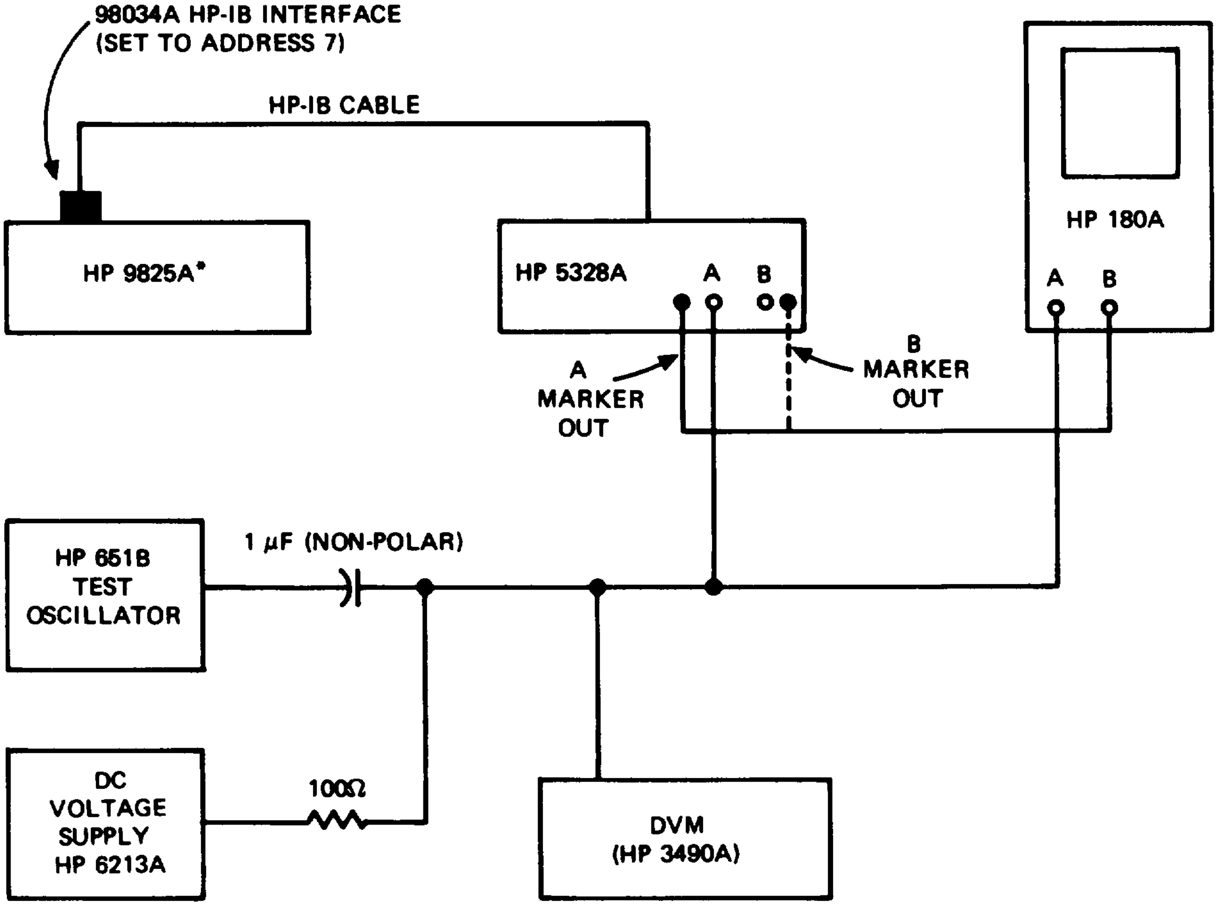
h. Reconfigure dc power supply for negative voltages and set the voltage for -2.00 volts (±2 mv).

i. Execute the following from the keyboard of the 9825A:

wrt 7Ø1, "PF4C5S1S3A379-200*B37-200*R"

j. Adjust All R26 for a 50% duty cycle on the A Marker output signal.

k. Connect the 5328A B Marker output to the B channel of the oscilloscope. Adjust A11R17 for a 50% duty cycle on the B Marker output signal.



*9825A should have either the 98213A General I/O-Extended I/O ROM or the 98214A Plotter-General I/O-Extended I/O ROM.

Figure 5-2. DAC Adjustment Equipment Connections

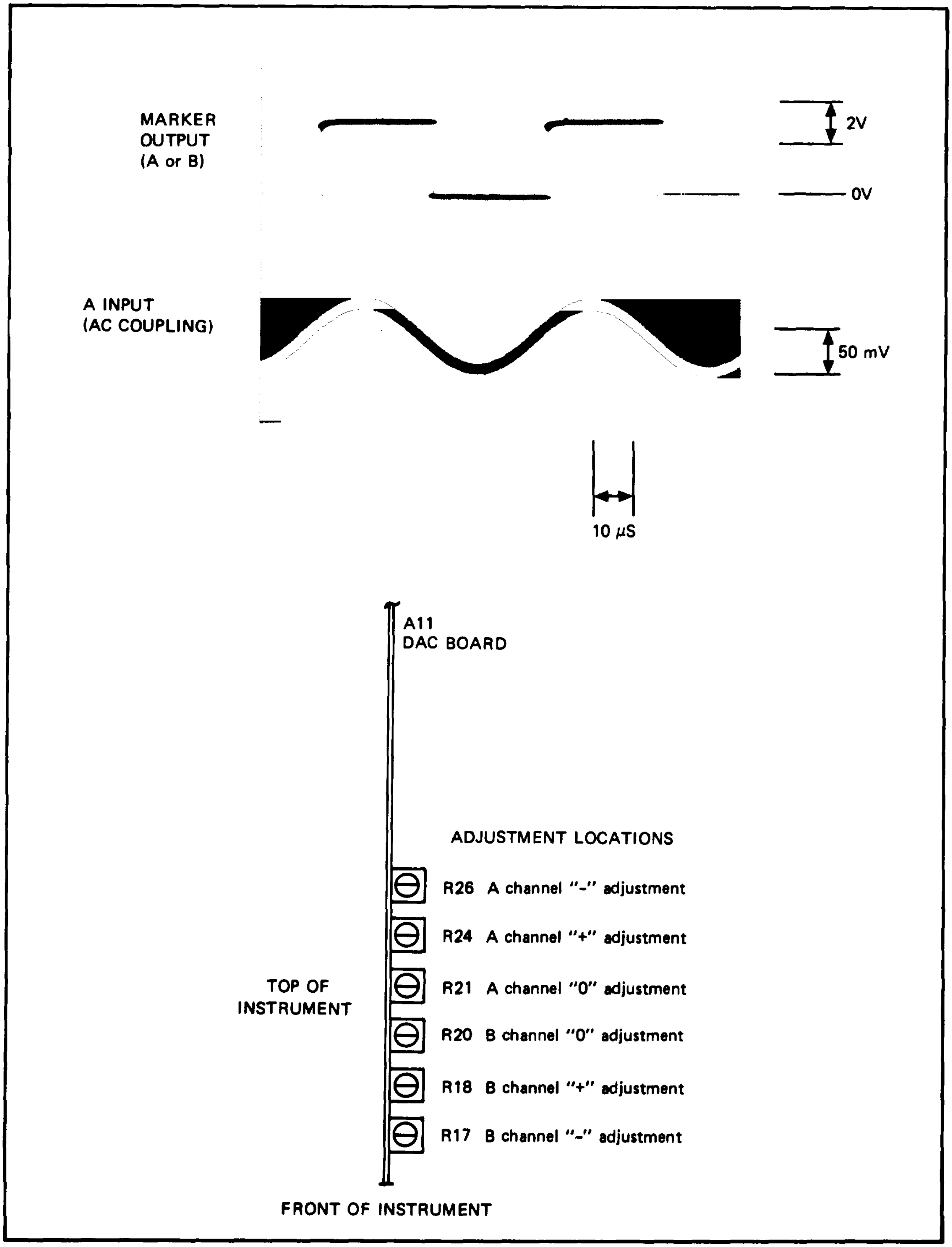


Figure 5-3. DAC Adjustment oscilloscope readout and adjustment locations

5-26. Adjustment of A3 Oscillator Support

1. Connect 5328A, HP 8640, and HP 180 as shown in Figure 5-4.

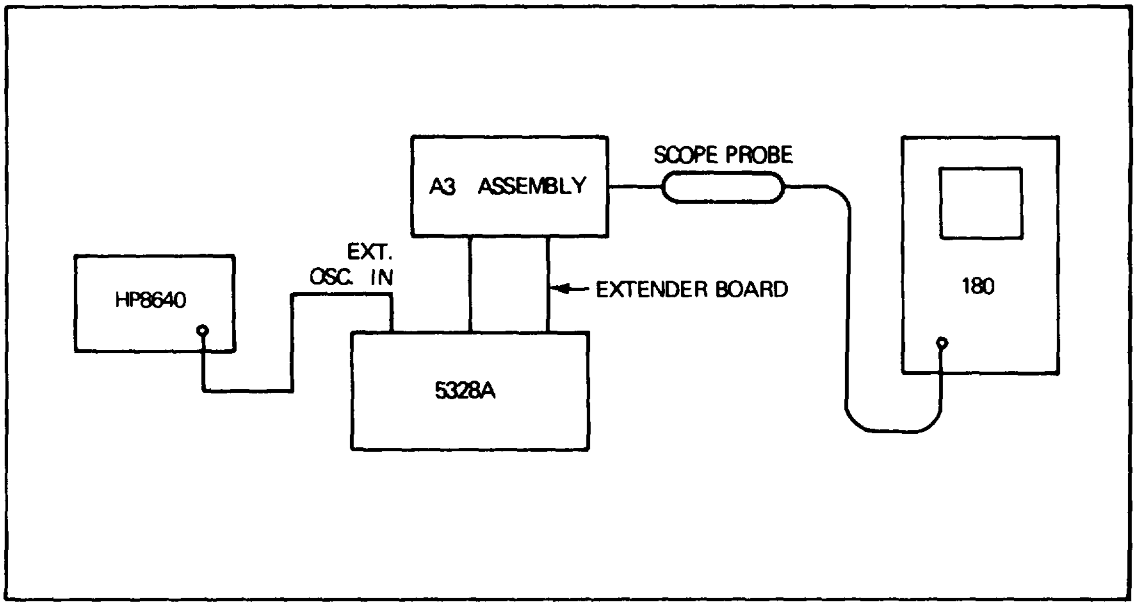


Figure 5-4. Hookup For A3 Oscillator Support Adjustment

2. Place A3 on an extender board,
3. Apply a 1 MHz signal at a level greater than 1V rms to the 5328A rear-panel EXT OSC IN.
4. With scope probe, monitor A3U2 (6) non-component side of A3 circuit board.
5. Adjust A3C15 and A3C12 to minimize side-jitter in trace, as shown in Figure 5--5.
6. Put the scope in X10 and fine-tune the adjustments for minimum jitter.

5-27. TROUBLESHOOTING

5-28. Trouble isolation can best be accomplished by obtaining all possible information from the controls, connectors, and indicators on the 5328A. This information should then be analyzed by conducting the Performance Test (Table 5-4) to aid in determining symptoms of the trouble. Troubleshooting aids are described in the following paragraphs,

5-29. TROUBLESHOOTING AIDS

5-30. Troubleshooting flowcharts for each assembly of the 5328A are provided at the back of this section. Extender boards and test cards are available as service kits. This section contains a table for analysis of functional signals and a table for IC troubleshooting.

5-31. Extender Board (05328-62016)

5-32. Two of these extender boards are supplied with the 5328A to extend the A4 Function Selector Assembly or the A8 Frequency C Assembly. One of these extender boards is required to extend the A10 assembly for the standard 5328A.

A3 Out of Adjustment

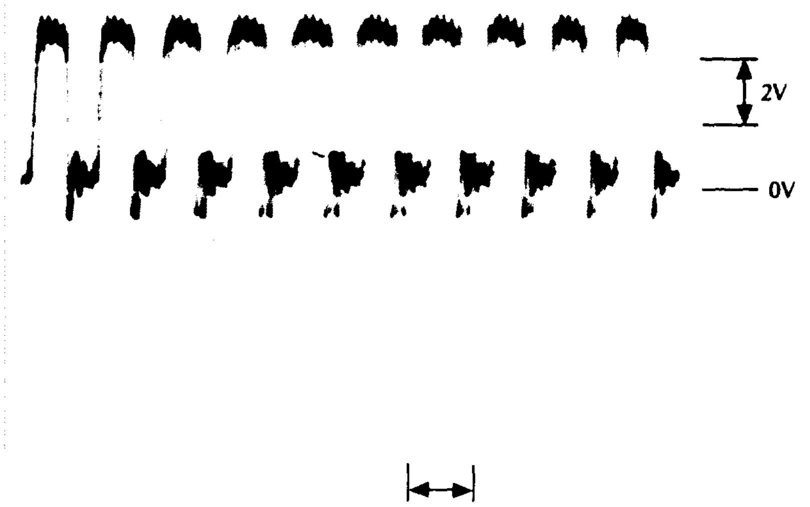


Figure 5-5A

C15, C12 Adjusted for Minimum Jitter

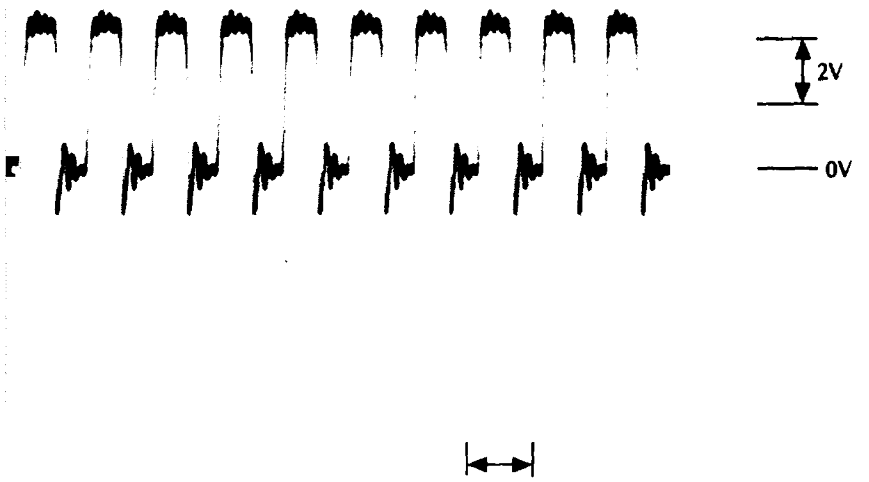


Figure 5-5B

Figure 5-5. A3 Jittler Adjustment

5-33. IC Troubleshooting

5-34. To troubleshoot the IC's on the A1 Motherboard, proceed as follows:

a. Set the FUNCTION switch to CHECK.

b. Set the FREQ RESOLUTION, N switch to 1 MHz, 1.

c. Remove top cover and remove A4 Function Selector Assembly.

d. Apply power and check for the logic states as shown in Table 5-5, using an HP Model 10528A Logic Clip or a Model 10525T Logic Probe. A dark pattern indicates a logic high.

5-35. Function Signals

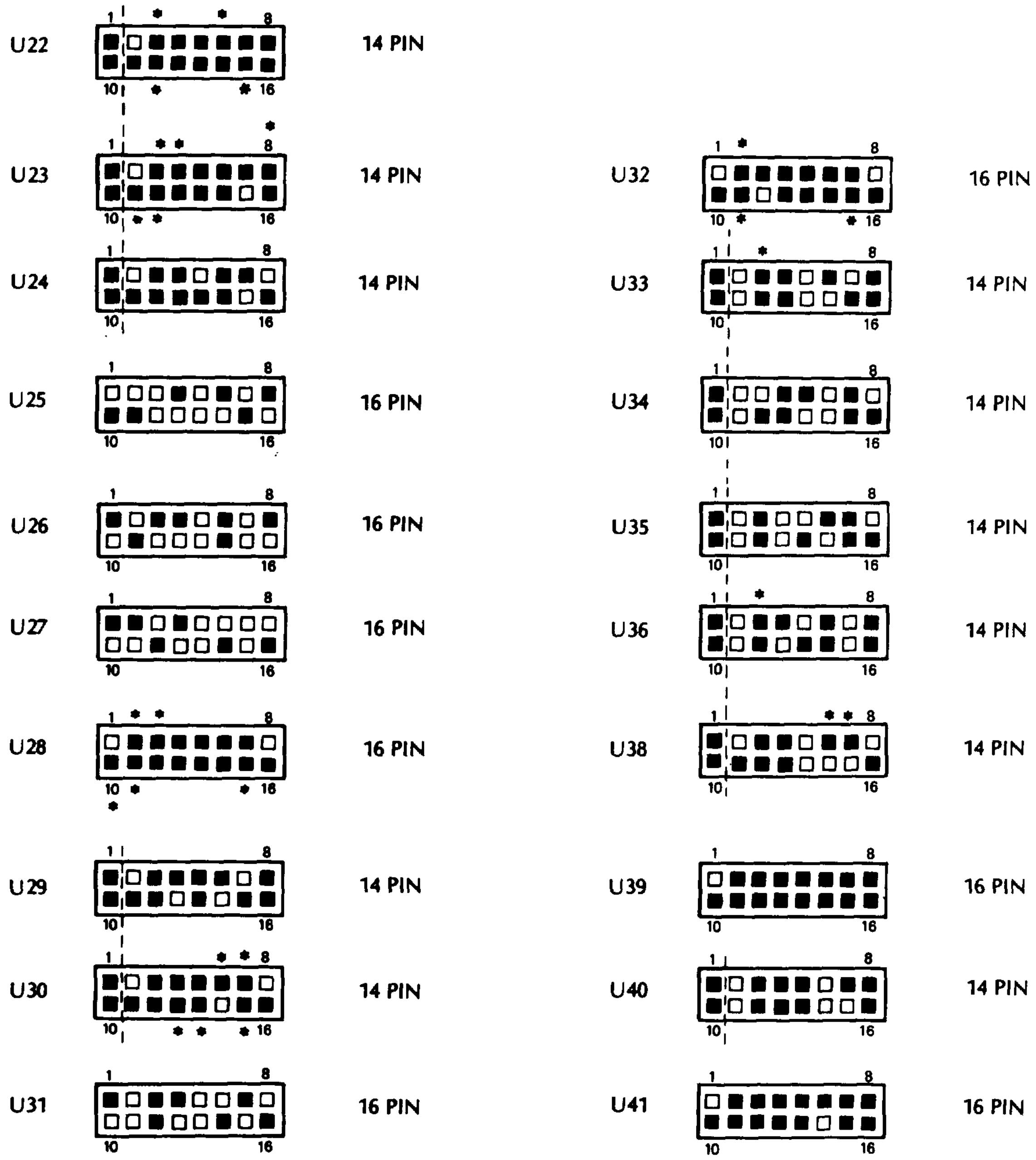
5-36. *Table* 5-6 lists the functional signals at pertinent points for each position of the FUNCTION switch. This information can be used to isolate problems that may occur in any of the various modes of operation.

Table 5-5 IC Troubleshooting, A1 Motherboard

5328A Display: ■■■■0.00 7■
(See preceding initial conditions)

NOTE

When checking a 14-pin IC with the 16-pin logic clip, ignore the patterns for pins 8 and 9 of the Logic Clip as shown by the dotted line on the pattern.



*Indicates dimly lit

Table 5-5. IC Troubleshooting, A1 Motherboard (Continued)

PINS		FUNCTION: CHECK	FREQ C	FREQ C	PER A	PER AVG A	RATIO B/A	TI A→B	TI AVG A→B	RATIO C/A
U25										
INPUTS	2	L	L	L	H	H	H	H	H	H
	3	H	H	H	L	L	H	L	L	H
	6	H	L	H	H	H	H	H	H	L
	7	H	L	H	L	L	H	L	L	L
OUTPUTS	9	H	L	L	L	L	L	L	L	L
	10	H	H	H	H	H	H	H	H	H
	15	L	L	L	L	L	L	L	L	L
	16	L	H	L	H	H	L	H	H	H
U26										
INPUTS	2	L	H	L	L	L	L	L	L	H
	3	H	L	H	H	H	H	H	H	L
	6	H	L	H	L	L	L	L	L	L
	7	L	H	H	H	H	L	L	L	H
OUTPUTS	9	L	L	L	L	L	L	L	H	L
	10	H	L	L	H	H	H	H	H	L
	15	L	L	L	L	L	L	L	L	L
	16	L	L	L	L	L	L	L	L	L
U27										
INPUTS	2	L	L	L	L	L	L	L	L	L
	3	L	L	L	H	H	H	H	H	H
	6	L	L	L	L	L	H	L	L	H
	7	H	H	H	H	H	H	H	H	H
OUTPUTS	9	L	L	L	H	H	H	H	H	H
	10	L	L	H	H	H	L	H	H	L
	15	L	H	L	L	L	L	L	L	H
	16	L	L	L	L	L	L	L	L	L
U31										
INPUTS	2	H	H	H	L	L	L	L	L	L
	3	L	L	L	L	L	L	L	L	L
	6	H	H	H	L	L	H	L	L	H
	7	L	L	L	L	L	H	L	L	H
OUTPUTS	9	L	L	L	L	L	L	H	H	L
	10	L	L	L	L	L	L	L	L	L
	15	L	L	H	L	L	L	L	L	L
	16	H	H	H	L	L	L	L	L	L

Table 5-5. IC Troubleshooting, A1 Motherboard (Continued)

PINS		FREQ RESOLUTION							
		1 MHz 1	.1 MHz 10	10 kHz 10^2	1 kHz 10^3	.1 kHz 10^4	10 Hz 10^5	1 Hz 10^6	.1 Hz 10^7
U25									
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	H	H	H	H
	6	H	H	L	L	H	H	L	L
	7	H	L	H	L	H	L	H	L
OUTPUTS	9	H	H	H	H	H	H	H	H
	10	H	H	H	H	H	H	H	H
	15	L	H	L	H	L	H	L	H
	16	L	L	L	L	L	L	L	L
U26									
INPUTS	2	L	L	L	L	L	L	L	L
	3	H	H	H	H	L	L	L	L
	6	H	H	H	H	H	H	H	H
	7	L	L	L	L	L	L	L	L
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	H	H	H	H	H	H	H	H
	15	L	L	L	L	L	L	L	L
	16	L	L	L	L	H	H	H	H
U27									
INPUTS	2	L	L	L	L	L	L	L	L
	3	L	L	L	L	L	L	L	L
	6	L	L	L	L	L	L	L	L
	7	H	H	H	H	H	H	H	H
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L
	16	L	L	H	H	L	L	H	H
U31									
INPUTS	2	H	H	H	H	H	H	H	H
	3	L	L	L	L	L	L	L	L
	6	H	H	H	H	H	H	H	H
	7	L	L	L	L	L	L	L	L
OUTPUTS	9	L	L	L	L	L	L	L	L
	10	L	L	L	L	L	L	L	L
	15	L	L	L	L	L	L	L	L
	16	H	H	H	H	H	H	H	H

Table 5-5. IC Troubleshooting, A1 Motherboard (Continued)

U37
(ROM STATES WITH A4 REMOVED)

1	-2V	15	L
2	+5V	16	GND
3	L	17	L
4	L	18	L
5	L	19	L
6	L	20	H
7	H	21	H
8	L	22	L
9	H	23	L
10	H	24	H
11	H	25	H
12	H	26	H
13	L	27	L
14	L	28	+12V

Table 5-6. 5328A Functional Signals

NOTE
N=0–7 (Exponent of 10 on FREQ RESOLUTION, N Switch.
N=0 is position 1 on switch. All other positions N≠0).
CLK = 10 MHz
* = Don't care

Function Switch	Displayed Number FREQ • TIME (Hz) (Seconds)	Signal to TB (Output A4U10) IF N=0	IF N≠0	Signal to 1st Decade (Output A4U6) IF N=0	N≠0	Arming (Output A4U5) Norm	Armed	Main Gate (Input A4U6) IF N=0	IF N≠0	Gate (Opt. 030) (Input A8U4)
FREQ A	$A \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	A	A	A	B	MGFF	MGFF	*
PER A	$\frac{CLK}{10^N} \bullet$ PER A	*	CLK	GOSC	TBO	Free	B	Open	TI	*
PER AVG A	CLK • 10^N PER A	*	A	GOSC	CLK	Free	B	Open	MGFF	*
TI A→B	$\frac{CLK}{10^N} \bullet$ TO A→B	*	CLK	GOSC	TBO	Free	CA	Open	TI	*
TI AVG A→B	(CLK • 10^N) • TI A→B	*	B	GOSC	GOSC	Free	CA	Open	MGFF	*
FREQ C (Option 030)	$C \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	C	C	CA	B	Open	Open	MGFF
RATIO B/A	$B \bullet \frac{10^N}{A}$	†*	A	B	B	Free	CA	TI	MGFF	*
RATIO C/A	$C \bullet \frac{10^N}{A}$	*	A	C	C	Free	B	Open	Open	TI IF N=0 MGFF IF N≠0
CHECK	$CLK \bullet \frac{10^{(N+1)}}{CLK}$	CLK	CLK	CLK	CLK	Free	B	MGFF	MGFF	*

NOTES
† = ROM makes "A" into period = gate time
CA = CARM

5-37. HP-IB VERIFICATION USING THE HP9825A

5-38. The following program checks the 5328AF/096/H42 for proper operation on the HP-IB. The program is designed to operate with the 5328AF/096/H42 connected to a HP9825A Desktop Computer as a controller.

5-39. To perform the verification, connect the 5328AF/096/H42 as shown in Figure 5-6, and set the rear panel address switches to decimal equivalent one.

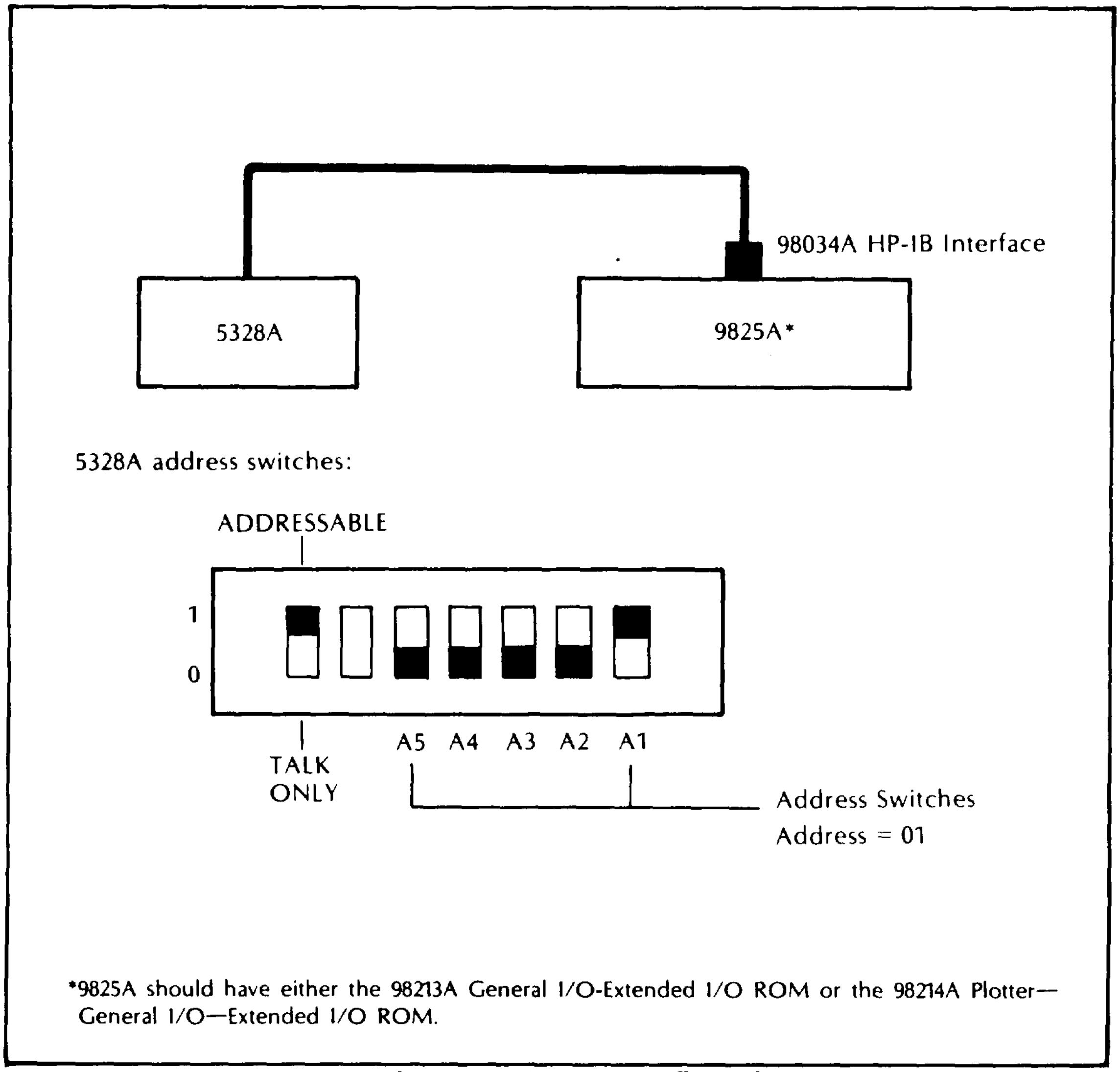


Figure 5-6. System Configuration

5-40. The program listed in Table 5-7 may be keyed into the 9825A or may be loaded from an HP-IB Verification cassette, HP P/N 59300-10001, (Revision E or later) which also contains HP-IB verification programs for the 59300 series of instruments, To run the program on the cassette, insert the cassette into the 9825A, Load file 0, and press RUN. Enter “5328” when the instrument model number is requested. The 9825A will then load into memory the 5328A verification program.

5-41. The 5328A HP-IB Verification Program goes through 17 check points. The information in Table 5-8A, B, C tells what occurs during each test and what should be observed by the operator if the test has been successfully completed. At the conclusion of each test, the program stops and displays the current check point. To advance to the next test, simply press **CONTINUE.** If it is desired to repeat a test, set the variable L to 1 via the keyboard (1-L **EXECUTE),** then press **CONTINUE.** To go on to the next test after looping, set L back to O when the program halts (**O→L EXECUTE),** then press **CONTINUE.**

```
5328AF/096 OR
5328A/H42

  HP-IB TESTS

-----------------
CHECK POINT 1
*REMOTE


-----------------
CHECK POINT 2
*CHECK=
 +   10.0000E+6


-----------------
CHECK POINT 3
RESOLUTION
 +      10.00E+6
 +     10.000E+6
 +    10.0000E+6
 +   10.00000E+6
 + 10.000000E+6
 +10.0000000E+6
0+0.00000000E+6
-----------------
CHECK POINT 4
*FREQ A


-----------------
CHECK POINT 5
*RATIO B/A


-----------------
CHECK POINT 6
*PERIOD A


-----------------
CHECK POINT 7
*PER.AVG.A


-----------------
CHECK POINT 8
*T.I.A→B


-----------------
CHECK POINT 9
*T.I.AVG.A→B


-----------------
CHECK POINT 10
FREQ C


-----------------
CHECK POINT 11
RATIO C/A


-----------------
CHECK POINT 12
*SAMPLE RATE
*SINGLE/MULTIPLE
 MEASMNT


-----------------
CHECK POINT 13
*ATTENUATOR


-----------------
CHECK POINT 14
*SEPARATE/COMMON
*NORMAL/INVERTED


-----------------
CHECK POINT 15
*COUPLING


-----------------
CHECK POINT 16
*TRIGGER LEVELS
CHNL B,+SLOPE
CHNL B,-SLOPE
CHNL A,+SLOPE
CHNL A,-SLOPE


-----------------
CHECK POINT 17
BUS COMMANDS:
*LOCAL LOCKOUT
*DEVICE CLEAR
*SELECTED DEVICE
 CLEAR
*GROUP EXECUTE
 TRIGGER
*SERIAL POLL
 STATUS BYTE=
       6.40e 01
*GO TO LOCAL


END OF TEST
```

Figure 5-7. Sample Printout

Table 5-7. Program Listing

```
0: dim C$[40];dsp "MODEL5328AF/096/H42 FREQ COUNTER"
1: prt "5328AF/096 OR"
2: prt "5328A/H42";spc 1
3: prt "  HP-IB TESTS";spc 1
4: "1":prt "----------------","CHECK POINT 1"
5: rem 701
6: prt "*REMOTE";beep;spc 2
7: dsp "CHECK POINT 1--PRESS CONTINUE";stp
8: if L=1;gto -6
9: prt "----------------","CHECK POINT 2"
10: wrt 701,"PF<G3S13R"
11: red 701,C$;prt "*CHECK=",C$;beep;spc 2
12: dsp "CHECK POINT 2--PRESS CONTINUE";stp
13: if L=1;gto -4
14: prt "----------------","CHECK POINT 3","RESOLUTION"
15: 1→X
16: "LOOP":fmt 2,"G",f.0,"R"
17: wrt 701.2,X
18: red 701,C$;prt C$
19: X+1→X
20: if X=8;gto +2
21: gto "LOOP"
22: dsp "CHECK POINT 3--PRESS CONTINUE";beep;stp
23: if L=1;gto -9
24: prt "----------------","CHECK POINT 4"
25: wrt 701,"F4R"
26: prt "*FREQ A";beep;spc 2
27: dsp "CHECK POINT 4--PRESS CONTINUE";stp
28: if L=1;gto -4
29: prt "----------------","CHECK POINT 5"
30: wrt 701,"F9R"
31: prt "*RATIO B/A";beep;spc 2
32: dsp "CHECK POINT 5--PRESS CONTINUE";stp
33: if L=1;gto -4
34: prt "----------------","CHECK POINT 6"
35: wrt 701,"F6R"
36: prt "*PERIOD A";beep;spc 2
37: dsp "CHECK POINT 6--PRESS CONTINUE";stp
38: if L=1;gto -4
39: prt "----------------","CHECK POINT 7"
40: wrt 701,"F7R"
41: prt "*PER.AVG.A";beep;spc 2
42: dsp "CHECK POINT 7--PRESS CONTINUE";stp
43: if L=1;gto -4
44: prt "----------------","CHECK POINT 8"
45: wrt 701,"F8R"
46: prt "*T.I.A→B";beep;spc 2
47: dsp "CHECK POINT 8--PRESS CONTINUE";stp
48: if L=1;gto -4
49: prt "----------------","CHECK POINT 9"
50: wrt 701,"F:R"
```

Table 5-7. Program Listing (Continued)

```
51: prt "*T.I.AVG.A+B";beep;spc 2
52: dsp "CHECK POINT 9--PRESS CONTINUE";stp
53: if L=1;gto -4
54: prt "----------------","CHECK POINT 10"
55: wrt 701,"F>R"
56: prt "FREQ C";beep;spc 2
57: dsp "CHECK POINT 10--PRESS CONTINUE";stp
58: if L=1;gto -4
59: prt "----------------","CHECK POINT 11"
60: wrt 701,"F=R"
61: prt "RATIO C/A";beep;spc 2
62: dsp "CHECK POINT 11--PRESS CONTINUE";stp
63: if L=1;gto -4
64: prt "----------------","CHECK POINT 12"
65: wrt 701,"F<G1S137R"
66: dsp "MANUAL OK?--PRESS CONTINUE";stp
67: prt "*SAMPLE RATE"
68: wrt 701,"S60R"
69: dsp "GATE LIGHT OFF?-PRESS CONTINUE";stp
70: prt "*SINGLE/MULTIPLE MEASMNT";beep;spc 2
71: dsp "CHECK POINT 12--PRESS CONTINUE";stp
72: if L=1;gto -8
73: "13":prt "----------------","CHECK POINT 13"
74: wrt 701,"PF4G4S13A379B37R"
75: dsp "STEPS 1,2-PRESS CONTINUE";stp
76: wrt 701,"PF4G4S13A139B13R";wait 1000
77: prt "*ATTENUATOR";beep;spc 2
78: dsp "CHECK POINT 13--PRESS CONTINUE";stp
79: if L=1;gto -6
80: "14":prt "----------------","CHECK POINT 14"
81: dsp "STEP 3--PRESS CONTINUE";stp
82: wrt 701,"PF9G3S13A79B7R"
83: wait 2000
84: dsp "STEP 4--PRESS CONTINUE";stp
85: wrt 701,"PF4G5S13B79R";wait 2000
86: prt "*SEPARATE/COMMON","*NORMAL/INVERTED";beep;spc 2
87: dsp "CHECK POINT 14-PRESS CONTINUE";stp
88: if L=1;gto -8
89: "15":prt "----------------","CHECK POINT 15"
90: wrt 701,"PF4G4S13A79B7R"
91: dsp "STEPS 5,6--PRESS CONTINUE";stp
92: wrt 701,"PF4G4S13A379B37R"
93: prt "*COUPLING";beep;spc 2
94: dsp "CHECK POINT 15-PRESS CONTINUE";stp
95: "16":prt "----------------","CHECK POINT 16"
96: wrt 701,"PF4G6S136A379+000*B37+000*R"
97: dsp "STEPS 7,8--PRESS CONTINUE";stp
98: wrt 701,"PF4G6S136A379+040*B37+040*R"
99: prt "*TRIGGER LEVELS"
100: dsp "TRIGGER LVLS-PRESS CONTINUE";stp
```

Table 5-7. Program Listing (Continued)

```
101: dsp "STEPS 9,10,11,12-PRESS CONTINUE";stp
102: wrt 701,"PF:S137A379+040*B37+050*R"
103: prt "CHNL B,+SLOPE"
104: dsp "CHANNEL B,+SLOPE--PRESS CONTINUE";stp
105: wrt 701,"PF:S137A379+040*B375+050*R"
106: prt "CHNL B,-SLOPE"
107: dsp "CHNL B,-SLOPE--PRESS CONTINUE";stp
108: wrt 701,"PF:S137A379+050*B375+040*R"
109: prt "CHNL A,+SLOPE"
110: dsp "CHNL A,+SLOPE-PRESS CONTINUE";stp
111: wrt 701,"PF:S137A3795+050*B375+040*R"
112: prt "CHNL A,-SLOPE";spc 2
113: dsp "CHNL A,-SLOPE-PRESS CONTINUE";stp
114: dsp "CHECK POINT 16-PRESS CONTINUE";stp
115: if L=1;gto "16"
116: "17":prt "----------------","CHECK POINT 17"
117: prt "BUS COMMANDS:"
118: rem 701;dsp "REMOTE?-PRESS CONTINUE";stp
119: llo 7;dsp "LOCAL LOCKOUT?-PRESS CONTINUE";stp
120: prt "*LOCAL LOCKOUT"
121: wrt 701,"PF<S13G3R"
122: dsp "10.000MHZ?-PRESS CONTINUE";stp
123: clr 7;prt "*DEVICE CLEAR";beep
124: dsp "DCL-PRESS CONTINUE";stp
125: wrt 701,"PF<S13G3R"
126: dsp "10.000MHZ?-PRESS CONTINUE";stp
127: clr 701;prt "*SELECTED DEVICE CLEAR";beep
128: dsp "SDC-PRESS CONTINUE";stp
129: wrt 701,"PF<G3S0G3R"
130: dsp "IN HOLD?-PRESS CONTINUE";stp
131: wait 1000;trg 7;beep;wait 2000;trg 701;beep;wait 1000
132: prt "*GROUP EXECUTE  TRIGGER"
133: dsp "GET-PRESS CONTINUE";stp
134: wrt 701,"PF<G7S12R"
135: rds(701)→A;dsp A
136: if A=0;gto -1
137: prt "*SERIAL POLL"," STATUS BYTE=",A
138: dsp "SERIAL POLL-PRESS CONTINUE";stp
139: lcl 7;dsp "COUNTER IN LOCAL?-PRESS CONTINUE";stp
140: prt "*GO TO LOCAL";spc 2
141: rem 701
142: dsp "CHECK POINT 17-PRESS CONTINUE";stp
143: if L=1;gto "17"
144: "END":dsp "END OF TEST"
145: prt "END OF TEST";beep;spc 5
146: end
*17327
```

Table 5-8A. Program Description

Check Point	Test	Observe on 5328A
1	REMOTE	Front panel (RMT) annunciator should be on.
2	CHECK	Counter should read 10.000 MHz.
3	RESOLUTION	The 9825A should print and counter display the 10 MHz check signal with resolutions from 0.1 Hz to 1.0 MHz.
4	FREQ A	Counter display should read 0.0000 KHz.
5	RATIO B/A	Counter display should read 0.0000000
6	PERIOD A	Counter display should read 0. s
7	PER. AVE. A	Counter display should read 0.00000 ns
8	T.I. A-B	Counter display should read 0. s
9	T.I. AVG. A-B	Counter display should read 0.00000 ns
10	FREQ C	Counter display should read 0.0000 KHz
11	RATIO C/A	Counter display should read 0.0000000
12	SAMPLE RATE	When calculator displays MANUAL OK?, verify that front panel SAMPLE RATE control can be manually adjusted as seen from GATE LIGHT flashing rate.
	SINGLE/ MULTIPLE MEASMNT	When calculator displays GATE LIGHT OFF?, verify that Gate Light is truly off.

5-42. Connect a function generator to the 5328 input channels and monitor the signal with an oscilloscope as shown in *Figure 5-8.*

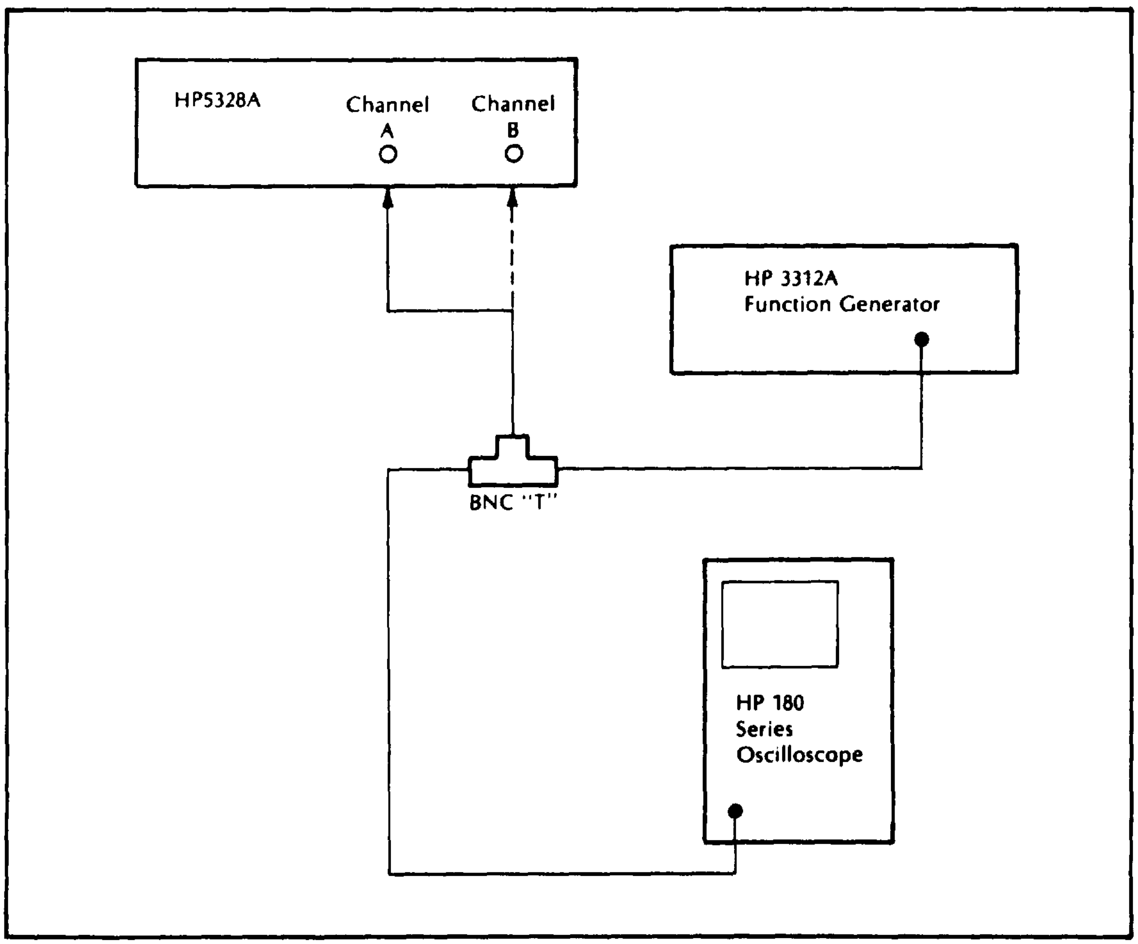


Figure 5-8. Hookup for tests described in Table 5-8B & C

Table *5-8B. Program Description*

Check Point	Step	Test	Counter Display Readout
13	1	ATTENUATOR	Set the function generator to an output of 1 kHz, 100 mV p-p sinewave centered at 0 vdc as seen on the oscilloscope. Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET. HP5328AF/096/H42 trigger lights should be blinking.
	2		When the 9825A **CONTINUE** key is pressed, verify that the counter trigger lights stop blinking.
14	3	SEPARATE/ COMMON NORMAL/ INVERTED	With function generator connected to Channel A of counter, when **CONTINUE** key of 9825A is pressed, verify counter readout as 1.000.
	4		With function generator connected to Channel B of counter, when **CONTINUE** key of 9325A is pressed, counter should display approximately 1.00 kHz (frequency of function generator).
15	5	COUPLING	Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4 vdc offset *(Figure 5-9).* Connect signal to counter's Channel A input. Counter's Channel A and B trigger lights should be blinking.
	6		When the 9825A **CONTINUE** key is pressed, observe the counter's trigger lights stop blinking.
16	7	SLOPE/ TRIGGER LEVEL	Set the function generator to a triangular pulse output of 1 kHz at 300 mV p-p with a +0.4 vdc offset *(Figure 5-9).* Connect the function generator's output to Channel A of the counter. Set the counter's LEVEL A and B to PRESET.
	8		When the 9825A **CONTINUE** key is pressed, observe Channel A and B trigger lights commence blinking.
	9	Channel B + SLOPE	When the 9825A **CONTINUE** key is pressed, counter should display approximately 150µsec±75µsec (wide tolerance).
	10	Channel B - SLOPE	When the 9825A **CONTINUE** key is pressed, counter should display approximately 400µsec±100µsec (wide tolerance).
	11	Channel A + SLOPE	When the 9825A **CONTINUE** key is pressed, counter should display approximately 400µsec±100µsec (wide tolerance).
	12	Channel A - SLOPE	When the 9825A **CONTINUE** key is pressed, counter should display approximately 150µsec±75µsec (wide tolerance).

Table 5-8C. HP-IR Bus Commands

Check Point	Test	
17	LOCAL LOCKOUT (LLO)	When the 9825A CONTINUE key is pressed, verify that counter (RMT) annunciator is on. When the 9825A CONTINUE key is again pressed, verify Local Lockout by pressing front panel RESET button and ensuring counter doesn't go into Local operation. (RMT annunciator Off).
	DEVICE CLEAR (DCL)	When the 9825A CONTINUE key is pressed, verify that counter displays 10.000 MHz. When the 9825A CONTINUE key is again pressed, counter will reset to its Remote Program Initialize mode and display (O.).
	SELECTED DEVICE CLEAR (SDC)	When the 9825A CONTINUE key is pressed, verify that counter displays 10.000 MHz. When the 9825A CONTINUE key is again pressed, counter will reset to its Remote Program Initialize mode and display (O.).
	GROUP EXECUTE TRIGGER (GET)	When the 9825A CONTINUE key is pressed, verify that counter is in Hold (Gate Light off). When the 9825A CONTINUE key is pressed, Gate Light should flash twice and counter should display 10.000 MHz.
	SERIAL POLL (SPE/SPD)	When the 9825A CONTINUE key is pressed, counter should display (0.0000000 MHz) and GATE Light should go off. Calculator should print (STATUS BYTE = 64.00).
	GO TO LOCAL (GTL)	When the 9825A CONTINUE key is pressed, verify that counter is in Local (RMT annunciator off). When 9825A CONTINUE key is again pressed, counter will go into remote. END OF TEST

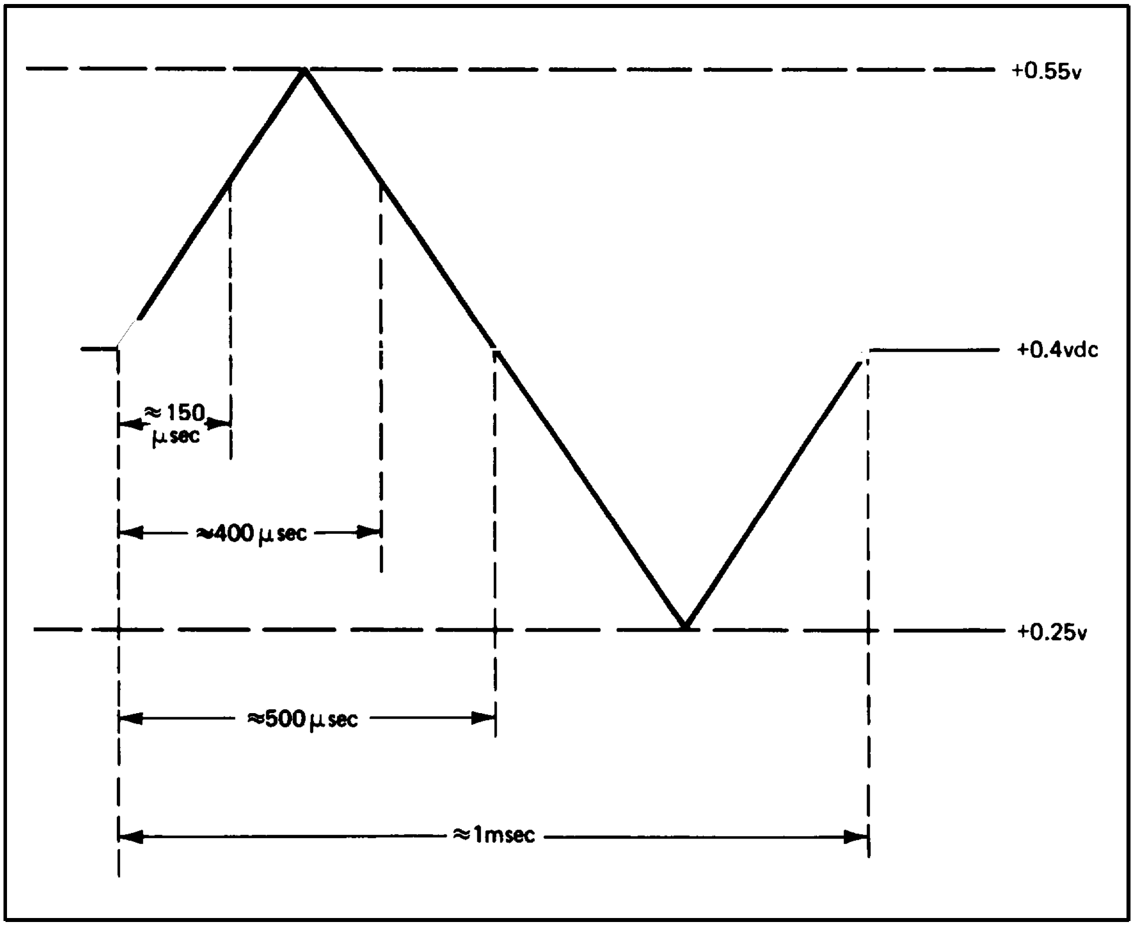


Figure 5-9. Triangular Pulse Oserved in Steps 5 and 7, Table 5-8B

Table 5-9. 5328A A15 Qualifiers and Signal Mnemonics

QUALIFIERS		
Signal	**Source**	**Description**
ADDR	U26(4)	H = My Listen Address
ANN	U32(3)	L = Annunciator On
ATN	U8(5)	L = Attention
BØ	U12(5)	16 State Sequence Count for Output of ASCII Code
B1	U12(6)	16 State Sequence Count for Output of ASCII Code
B2	U12(7)	16 State Sequence Count for Output of ASCII Code
B3	U12(9)	16 State Sequence Count for Output of ASCII Code
BLK	U6(7)	
D	U32(5)	H = Decimal Point has been Outputted
DAC	U8(7)	H = Data Accepted
DAV	U3(1)	L = Data is Valid
DIO1	U3(2)	HP-IB Data Bit 1
DIO2	U3(3)	HP-IB Data Bit 2
DIO3	U3(4)	HP-IB Data Bit 3
DIO4	U3(5)	HP-IB Data Bit 4
DIO5	U3(6)	HP-IB Data Bit 5
DIO6	U3(7)	HP-IB Data Bit 6
DIO7	U3(9)	HP-IB Data Bit 7
EOM	U8(1)	H = End of Measurement
J	U8(2)	Always HIGH, used for unconditional jump
LDP	U32(2)	L = Decimal Point On
LIS	U6(1)	H = Address to Listen
LLO	U19(9)	H = Local Lockout On
MA	U6(5)	L = Enable Strobe to Function Select Latch U34 and Select Bit on Module Strobe Code
MB	U6(6)	L = Enable Strobe to Time Base Select Latch U28 and Select Bit on Module Strobe Code
MLT	U32(6)	H = Make Multiple Measurements
MS	U29(3)	H = Module Strobe L = FC & TB Strobe
OVFL	U32(4)	L = Overflow
ODV	U32(7)	L = Wait until Addressed
RDF	U32(9)	H = Read Data on the fly
REN	U8(4)	L = Remote Enabled
RFD	U8(9)	H = Ready for Data
RMT		H = Option 011 in Remote
S	U32(1)	H = Measurement has dimension of time
SP	U32(1)	H = Serial Pole Active
SRQ	U6(3)	L = Service Request
SWL	U8(6)	H = Switch to Local
TALK A	U6(2)	L = Talk Always
TLK	U26(5)	H = Address to Talk

Table 5-9. 5328A A15 Qualifiers and Signal Mnemonics (Continued)

OUTPUTS		
Signal	**Source**	**Description**
LLIS		Unlisten
HLIS		Listen
LTLK		Untalk
HTLK		Talk
LSP		Serial Poll Disable
HSP		Serial Poll Enable
LMA		Enable Function Code Latch Input Module Select Code. Also used in putting out Exponent
HMA		Opposite of LMA
LS		Measurement does not have dimension of time. Output POS EXP
HS		Opposite of LS
HLTCH		Latch Data into U28, U33, or U34
LRMT		Go to Local
HRMT		Go to Remote
LD		Decimal Point has not been outputted
HD		Decimal Point has been outputted
LMB		Enable Time Base Code Latch input, Module Select Code. Also use in putting out Exponent
HMB		Opposite of LMB
LMS		Enable Function and Time Base Code Latches Disable Module Strobe Line
HMS		Opposite of LMS
LDAV		5328A says Data Not Valid
HDAV		5328A says Data Valid
LRFD		5328A says Not Ready for Data
HRFD		5328A says Ready for Data
LDAC		5328A says Data not Accepted
HDAC		5328A says Data Accepted
LLO		Local Lockout Off
HLLO		Local Lockout On
LEOM		Reset End of Measurement F/F (U11B)
HIC		Initialize 16 State Counter
HDSA		Strobe Mainframe Display and 16 State Counter
LRPR		Turn OFF Master Remote Programming Reset
HRPR		Turn ON Master Remote Programming Reset
LDDIS		Low Disable Display. TTL active low turns blanks display except LHS Annunciators
HDDIS		Opposite of HDDIS
LINH		Inhibit Counter from Arming
LRST		Turn OFF Counter Mainframe Reset
HRST		Turn ON Counter Mainframe Reset
LSRQ		Output (on U15, U24) Binary 0 on ASCII Bus
HSRQ		Output (on U15, U24) Binary 64 on ASCII Bus
ASP		Output (on U15, U24) ASCII space
LDAO		Output (on U15, U24) all HIGHS on Bus and Disarm DAC Line
HDAO		Output (on U15, U24) all HIGHS on Bus and Arm DAC Line All succeeding bits put out on U15, U24 to be put on HP-IB as ASCII Characters
ADIG		ASCII Digit from Display
ALF		ASCII Line Feed
AØ		ASCII Ø
ACR		ASCII Carriage Return
AE		ASCII E
ADP		ASCII Decimal Point
A3		ASCII 3
A6		ASCII 6
A9		ASCII 9
A+		ASCII +
A-		ASCII -
AOVF		ASCII Letter O

5-43. TROUBLESHOOTING INPUT CHANNELS

5-44. The main function of the input channels is to perform input signal conditioning via either local or remote control, Therefore, effective problem diagnosis is divided into two sections, local and remote. It is most efficient to assure proper local operation before remote section troubleshooting is performed. Use of the Performance Test *(Table 5-4)* will aid in determining which troubleshooting section to use.

5-45. Local Mode Troubleshooting

5-46. Local Mode Troubleshooting consists of the troubleshooting flowchart in Figure 5-5. These flowcharts are intended to help isolate local operation problems.

5-47. The flowchart in Figure 5-5 is intended for overall local operation troubleshooting. Table 5-10 Relay Operation shows required levels, control lines, and the relay involved for any function. *Table 5-11* Relay Control Logic shows the output line and level required for proper relay operation in a function. These tables, 5-10 and 5-11, are to be used with the Local Mode Troubleshooting Flowchart *(Figure 5-5).*

5-48. The programming interface section of the A10 Synchronizer board is used only when the 5328A is in remote. The interface is used in conjunction with the All board to control A and B channel signal conditioning. When the 5328A is in remote, addressable latches, U8 and U15, control all of the signal conditioning relays. The A11 DAC board is also used in remote to allow programming of the A and B channel trigger levels.

Table 5-10. A12 Relay Operation

J-1 Pin #	Function	J-1 PIN		Relay Controlled
		HI	LO	
2	Channel A Slope	—	+	———
5	Channel B Slope	—	+	———
6	Channel B Atten	X1	X10	K6, K11, K10
7	Channel B Coupling	DC	AC	K9
10	SEP/COM	COM	SEP	K4, K5
12	Channel A Atten	X1	X10	K2, K3, K8
14	Channel A Coupling	DC	AC	K7
NOTE: Nongrounded pins on J-1 should float to TTL high.				

Table 5–11. Relay Control Logic

Function	Channel A	Channel B
Slope +	A10J3 Pin 2 Low A10 J3 Pin 2 High	A10J3 Pin 5 Low A10J3 Pin 5 High
X1 Attn X10 X100	A10J3 Pin 12 High A10J3 Pin 12 Low A10J3 Pin 13 High	A10J3 Pin 6 High A10J3 Pin 6 Low A10J3 Pin 8 High
Coupling AC DC	A10J3 Pin 14 Low A10J3 Pin 14 High	A10J3 Pin 7 Low A10J3 Pin 7 High
SEP, COM A	SEP A10J3 Pin 10 Low COM A A10J3 Pin 10 High	

5-49. Remote Mode Troubleshooting

5-50. The following information includes Programming Logic Troubleshooting and DAC Troubleshooting. These areas will help isolate remote operation problems where A and B input channels operate correctly in local control.

5-51. Programming Logic Troubleshooting includes Tables 5-12 and 5-13. Table 5-12 Program Interface Operation shows the necessary levels that the A10 must generate in any function. Input and Output codes for ROM (A10U7) are contained in Table 5-13.

5-52. DAC Troubleshooting includes a checkout procedure that does not require a programming source. Table 5–14 DAC Logic Levels gives the required logic output levels for proper operation. The information in Table 5–15 DAC Signals is designed to aid in troubleshooting. It should be used to troubleshoot problems where the logic levels are correct, yet the analog output is bad.

5-53. DAC TROUBLESHOOTING. To perform DAC troubleshooting proceed as follows:

a. Check +5, -5.2, +15, and -15 volts on the A1 Motherboard (refer to A1 troubleshooting procedure for repair).

b. Check for clock signal on U5 pins 8 and 11 and on collector of Q7. If incorrect, suspect U5, Q7, or C12.

c. Perform the following setup procedure:

1. Turn 5328A power off and unplug 14-conductor cable from A11J1.
2. Remove DAC board A11 from 5328A and install jumpers in J1 from pins 8 to 10, 5 to 6, 4 to 7, and 3 to 12. Reinstall All board using an extender board (05328-62016) into XA11.

NOTE

Ensure jumper from pin 8 to 10 does not short to any of the other jumpers.

3. Apply power to an HP 10526T Logic Pulser.
4. Connect HP 3490A Voltmeter between A11TP5 and 5328A chassis (used to monitor Channel A DAC output).
5. Turn 5328A power switch to ON.

d. Pulse A11U11 (14) with the logic pulser. This resets the DAC storage registers. HP 3490 Voltmeter should display OV ±50 mV. If so, perform step 5. If not, refer to Table 5-14 and check the logic levels listed on line 1 (reset pulse U11(14)) for an improper level. Suspect any integrated circuit listed if it has an improper output.

e. Pulse A11J1(14) once with the logic pulser and verify line 2 of Table 5–14.

f. Pulse A11J1(14) three more times, stopping after each pulse to verify the next line of Table 5-14.

g. Steps a through f have checked the A channel DAC. To check the B channel DAC change the voltmeter connection to A11TP6 and 5328A chassis. Repeat steps d through f, pulsing A11J1 pin 13 instead of pin 14. The parentheses in Table 5-14 refer to B channel DAC circuit locations.

h. If the A and B channel DAC output voltages were the same as in Table 5-74 the board is functioning correctly. If a digital output from Table 5–74 is incorrect, suspect the integrated circuit generating the level. If the digital outputs are correct and the analog output is incorrect continue with step i.

i. Reset storage registers (U16, U15, U11, U10) by pulsing A11U10(14) with a logic pulser. Using an oscilloscope check signals listed in line 1 of Table 5-15.

j Pulse A11J1(14) and again using the oscilloscope check for signals in line 2 of Table 5–15.

k. Pulse A11J1 (14) three more times, stopping after each pulse to verify the next line in Table 5–15 with the oscilloscope.

l. Sets i through k have checked the A channel DAC signal path. To check Channel B DAC, follow steps i through k above, pulsing A11J1 pin 13 instead of 14. Stop after each pulse to verify the locations in parentheses of Table 5-15.

m. Refer to Table 5-16 match the symptom received with the probable cause of trouble.

Table 5-12. Program Interface Operation

Code	Function	A10U7 Pins 1 2 3 4 5 6	A10U8 Pins 4	5	6	7	9	10	12	A10U15 Pins 4	5	6	7	9	12	A10J3 Pins 2	5	6	7	8	9	10	11	12	13	14	A10U17 8
A0B0	1 Meg	0 1 1 0 0 0				0							0														
A3B3	DC	1 0 1 0 0 0			1							1							1							1	
A2B2	AC	0 0 1 0 0 0			0							0															
A5B5	—	1 0 0 0 0 0	1							1						1	1										
A4B4	+	0 0 0 0 0 0	0							0																	
A7B7	X1	1 1 0 0 0 0		1							1							1						1			
A6B6	X10	0 1 0 0 0 0		0							0																
A1B1	X100	1 1 1 0 0 0				1							1							1					1		
A9B9	Com A, Inv.	1 0 0 1 0 0					1							1							1		1				
A8B8	Sep, Norm	0 0 0 1 0 0					0							0													
A+1B+1	DAC	1 1 1 1 0 1							1						1												1
A*B*	NORM	0 1 1 1 1 0							0						0												0

NOTE

If U7 is good and U8 is bad, check for pulse one pins 9 and 10 of U16 for all commands and pins 6 and 7 for DAC command only. Pulse will occur during execution of command.

Table 5-13. ROM (A10U7) Input/Output Code

Input Code A10U7 Pins 14	13	12	11	10	Output Code A10U7 Pins 6	5	4	3	2	1
0	0	0	0	0	0	0	0	1	1	0
0	0	0	0	1	0	0	0	1	1	1
0	0	0	1	0	0	0	0	1	0	0
0	0	0	1	1	0	0	0	1	0	1
0	0	1	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	1
0	0	1	1	0	0	0	0	0	1	0
0	0	1	1	1	0	0	0	0	1	1
0	1	0	0	0	0	0	1	0	0	0
0	1	0	0	1	0	0	1	0	0	1
0	1	0	1	0	0	1	1	1	1	0
0	1	0	1	1	0	0	1	1	1	1
0	1	1	0	0	0	0	1	0	1	0
0	1	1	0	1	0	0	1	1	1	1
0	1	1	1	0	1	1	0	0	0	0
0	1	1	1	1	0	0	1	0	1	1
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1	0	0	0	1	1	0	0	1	1	1
1	0	0	1	0	1	0	0	1	0	0
1	0	0	1	1	1	0	0	1	0	1
1	0	1	0	0	1	0	0	0	0	1
1	0	1	0	1	1	0	0	0	0	0
1	0	1	1	0	1	0	0	0	1	0
1	0	1	1	1	1	0	0	0	1	1
1	1	0	0	0	1	0	1	0	0	0
1	1	0	0	1	1	0	1	0	0	1
1	1	0	1	0	0	1	1	1	1	0
1	1	0	1	1	1	0	1	1	1	1
1	1	1	0	0	1	0	1	0	1	0
1	1	1	0	1	1	0	1	1	1	1
1	1	1	1	0	1	1	0	0	0	0
1	1	1	1	1	0	0	1	0	1	1

Table 5–14. A11 DAC Logic Levels

	Least Significant Digit U10(14) 14	15	2	3	U9(13) 14	15	2	3	Most Significant Digit U8(12) 14	15	Sign TP2(1)	Output TP5(6)
Reset Pulse U11 Pin 14	0	0	0	0	0	0	0	0	0	0	0	0.000±.050 VDC
1 Pulse J1 Pin 14(13)	0	1	0	0	0	0	0	0	0	0	0	-0.020±.050 VDC
2 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	0	0	-0.220±.070 VDC
3 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	1	0	-2.220±.070 VDC
4 Pulses J1 Pin 14(13)	0	1	0	0	0	1	0	0	0	1	1	+2.22±.070 VDC

NOTE

This procedure does not exercise every bit. If DAC symptoms are that **some** voltages are not programmable, exercise each bit high by leaving that bit not shorted to ground.

Table 5-15. A 11 DAC Signals

	TP3(4)	A11U2 Pin 8(6) Pin 9(5)	Anode CR5, CR6 (2, 4)	Cathode CR8, CR10 (1, 3)	TP5(6)
Reset Pulse U11 Pin 14	No Pulses	No Pulses	No Pulses	No Pulses	0.00±0.05 VDC
1 Pulse J1 Pin 14(13)	10msec±4msec period pulses	10msec±4msec period pulses	10msec±4msec period pulses	≈+13 VDC	-0.02±0.05 VDC
2 Pulses J1 Pin 14(13)	1msec±0.4msec period pulses	1msec±0.4msec period pulses	1msec±0.4msec period pulses	≈+13 VDC	-0.22±0.07 VDC
3 Pulses J1 Pin 14(13)	100μsec±40μsec period pulses	100μsec±40μsec period pulses	100μsec±40μsec period pulses	≈+13 VDC	-2.22±0.07 VDC
4 Pulses J1 Pin 14(13)	100μsec±40μsec period pulses	100μsec±40μsec period pulses	≈-13 VDC	100μsec±40μsec period pulses	+2.22±0.07 VDC

NOTE

Pulse period is approximate; 40% variation may be normal since pulse spacing is not constant out of rate multiplier. Fainter pulses between brighter pulses may be seen. This is normal.

Table 5-16. A11 DAC Troubleshooting

Symptom	Probable Cause
Pulses wrong at TP4	U12, U13, or U14
Pulses wrong at TP3	U8, U9, or U10
Pulses wrong at U2 output	U2
Pulses wrong at drain of Q2	Q2, CR2, CR4, U1, or U3
Pulses wrong at drain of Q1	Q1, CR1, CR3, U1, or U3
Pulses wrong at drain of Q4	Q4, CR8, CR10, U4, or U3
Pulses wrong at drain of Q3	Q3, CR5, CR6, U4, or U3
If pulses at all points good	U4 for Channel A U1 for Channel B

5-54. REMOVAL AND REPLACEMENT INSTRUCTIONS

5-55. Removal and replacement instructions are provided for the instrument cover, the time interval module (assemblies A10 and A19) and A16 Display Assembly.

5-56. Instrument Cover Removal

5-57. To remove top or bottom cover, remove the screw at the rear edge that secures cover to instrument. Slide cover toward rear of instrument and lift off. To replace cover, reverse procedure.

WARNING

115 OR 230 VAC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.

5-58. Time Interval Module (Assemblies A10 and A19) Removal Replacement

5-59. To remove and replace the time interval module, proceed as follows:

a. Disconnect the power cable from the 5328A (Safety Precaution).

b. Remove rear feet and the top cover from the 5328A.

c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the cast front-panel frame.

d. Remove the two machine screws that secure the top of the module front panel to the top of the cast front-panel frame.

e. Turn the 5328A on its side and remove the two machine screws that secure the bottom of the module front panel to the bottom of the cast front-panel frame.

f. Slightly loosen all remaining machine screws along the top of the cast front-panel frame. This releases the compressive force on the module front panel.

g. Remove front panel nuts from A and B channel input connectors.

h. Remove the A19 Switch Board with front panel attached, by gently pushing the assembly from the rear. Note that the A19 board is separate from the A10 Synchronizer Assembly during this operation.

i. Remove the front panel from A19 by removing the MARKER OUTPUT connector nuts and removing the LEVEL A and B control knobs.

j. Remove the A10 Synchronizer Assembly by pulling the assembly upward.

k. Replacement is essentially the reverse of removal.

5-60 Display Assembly Removal and Replacement

5-61. To remove and replace the A16 Display Assembly, proceed as follows:

a. Disconnect the power cable from the 5328A (Safety Precaution).

b. Remove the top cover from the 5328A.

c. Using a suitable flat-blade screwdriver as a prying tool, gently remove the plastic filler strip from the top of the cast front-panel frame.

d. Remove the two machine screws that secure the top of the display front panel to the top of the cast front-panel frame.

e. Turn the 5328A on its side and remove the two machine screws that secure the bottom of the display front panel to the bottom of the cast front-panel frame.

f. Slightly loosen all remaining machine screws along the top of the cast front-panel frame. This releases the compressive force on the module front panel.

g. Remove the A16 Display Assembly, with front panel attached, by gently pushing the assembly from the rear. Note that the display assembly is separated from the A1 Motherboard during the operation.

h. Using a suitable allen wrench, remove the SAMPLE RATE control knob from the module.

i. Remove the nuts that attach the SAMPLE RATE and RESET switches and separate the front panel from the display assembly.

NOTE

If the FUNCTION or FREQ RESOLUTION switch control knob is removed or if the associated printed-circuit board switch is disassembled, the knob and switch must be aligned during replacement as described in the following paragraph.

j. To realign the display switches with the proper knob positions, set the rear ceramic wafers with the slots down. Set the knob of the FUNCTION switch to FREQ A and set the knob of the FREQ RESOLUTION switch to 10^2 (10 kHz). .1 kHz position and tighten the two set screws on each knob with a suitable allen wrench.

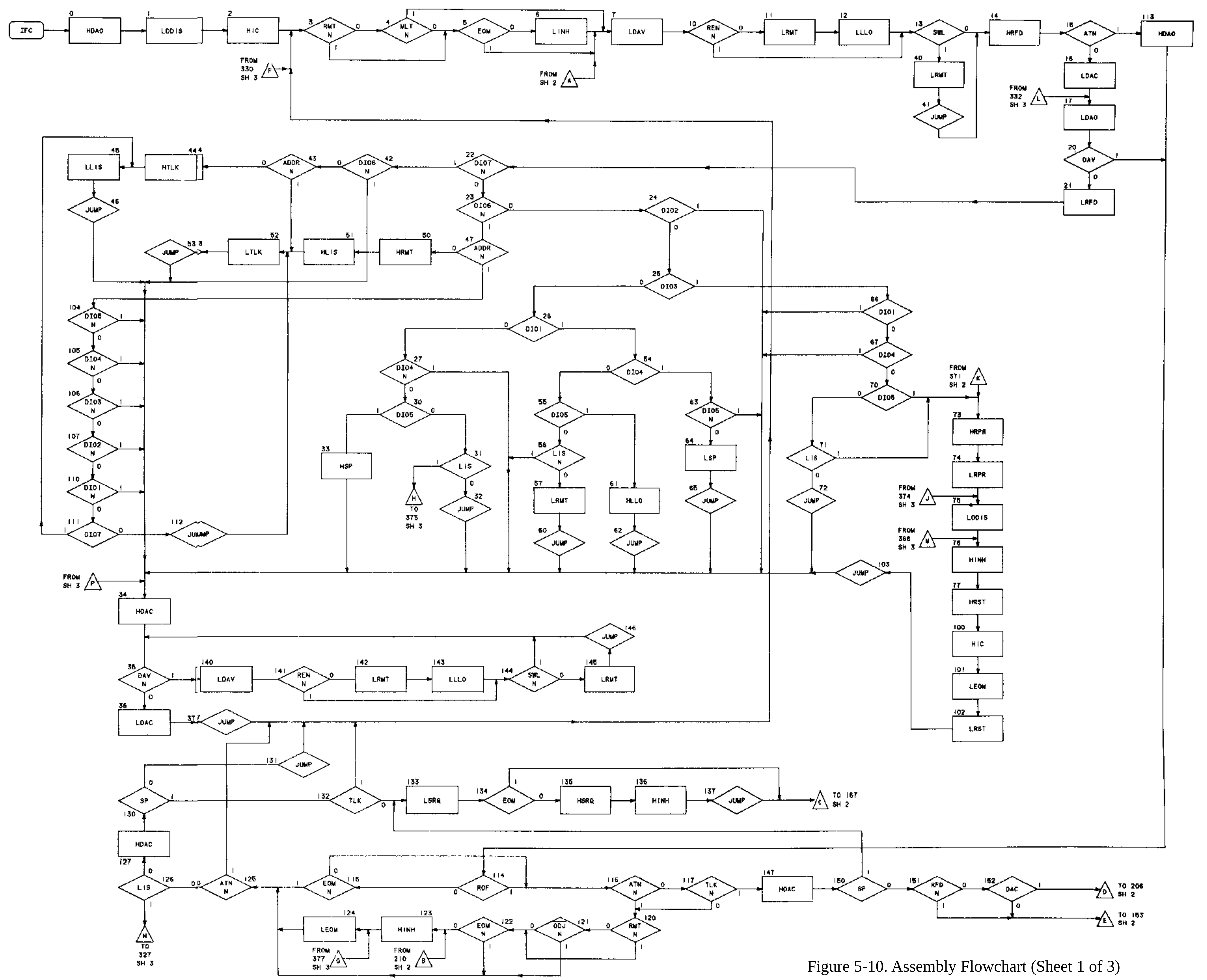


Figure 5-10. Assembly Flowchart (Sheet 1 of 3)

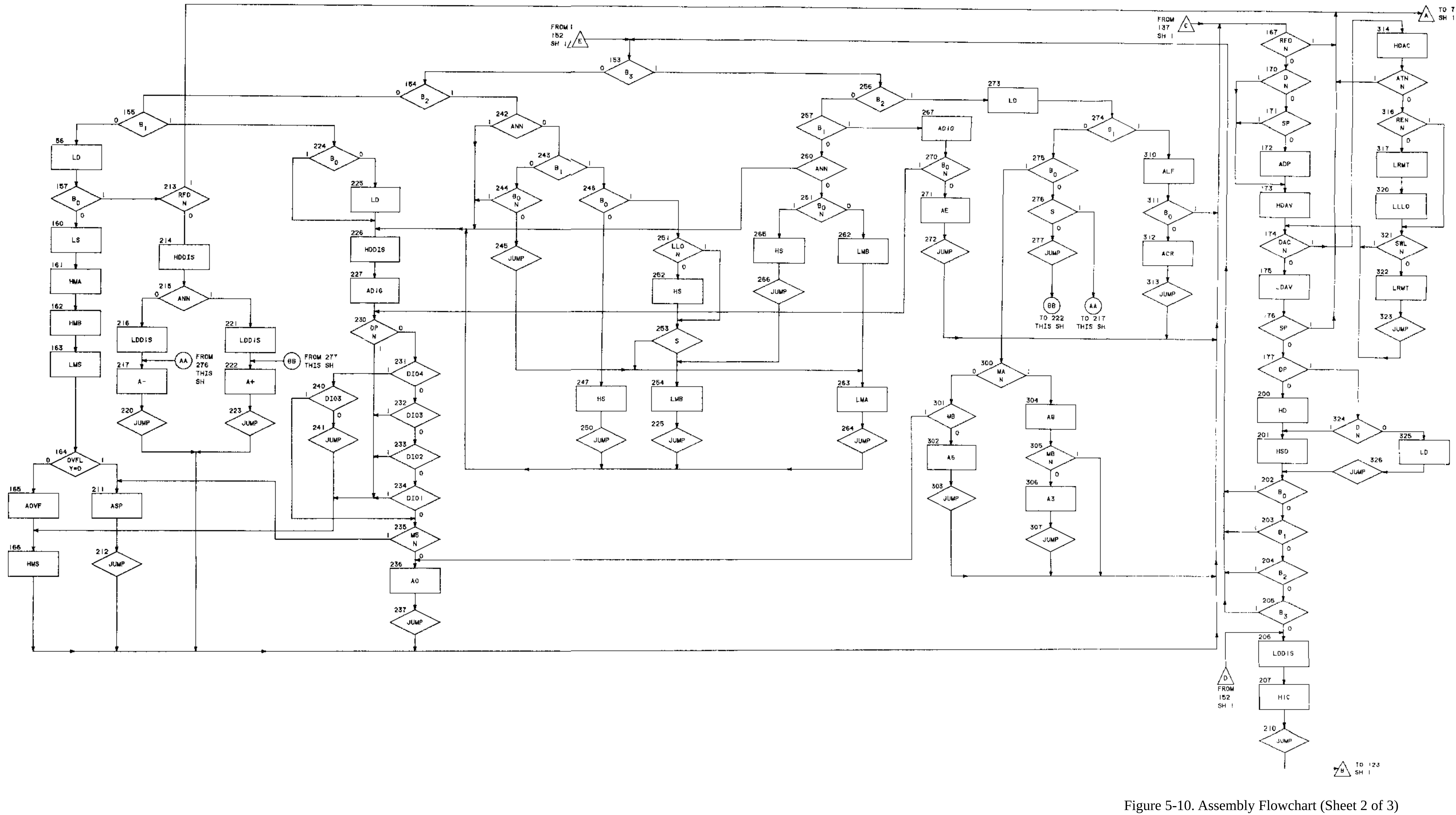


Figure 5-10. Assembly Flowchart (Sheet 2 of 3)

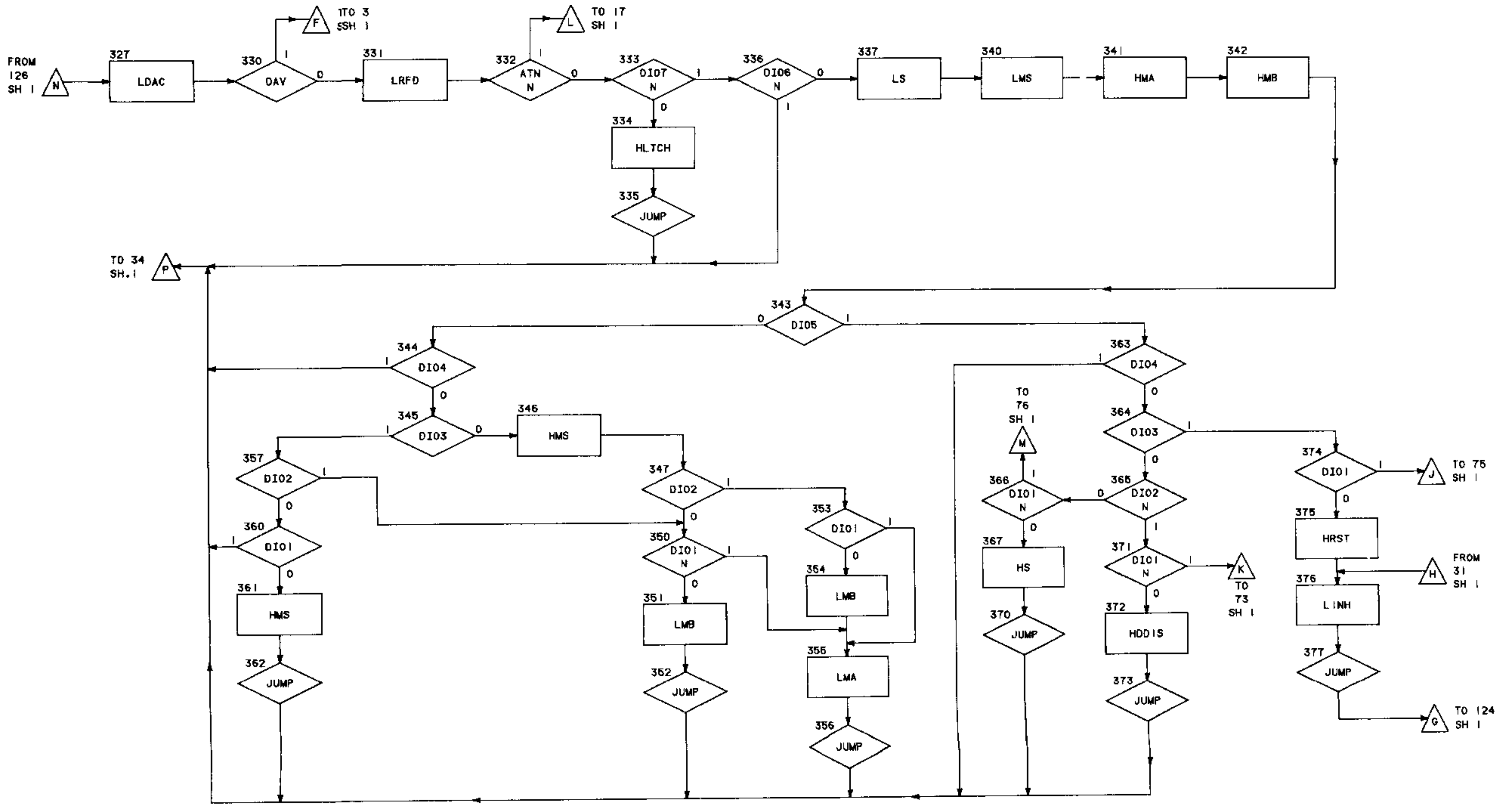
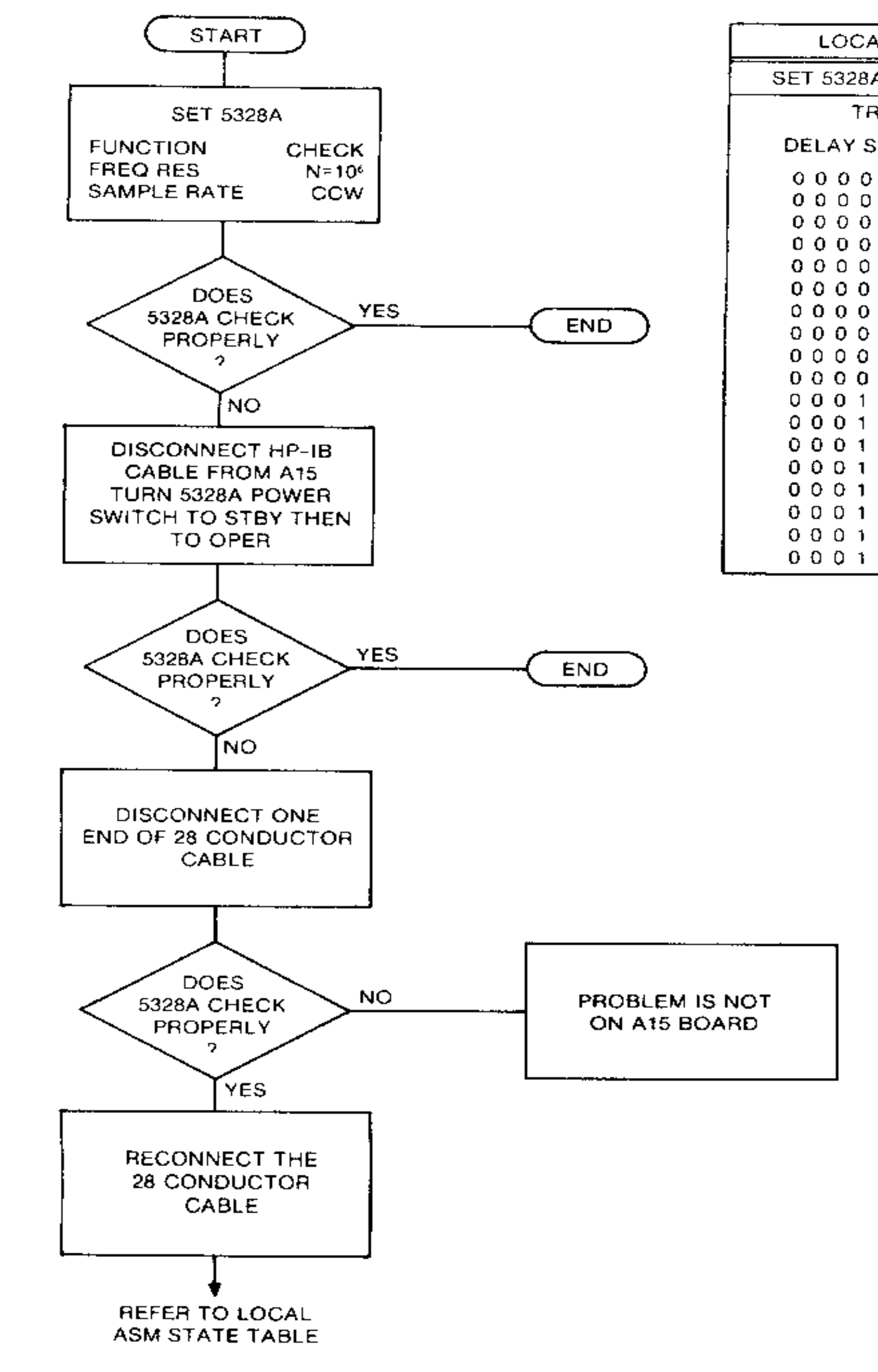


Figure 5-10. Assembly Flowchart (Sheet 3 of 3)



LOCAL ASM STATE TABLE	
SET 5328A FUNCTION TO FREQ A	
TRIGGER WORD 003	
DELAY SET	ADDRESS
0 0 0 0 0	3
0 0 0 0 1	5
0 0 0 0 2	6
0 0 0 0 3	7
0 0 0 0 4	1 0
0 0 0 0 5	1 1
0 0 0 0 6	1 2
0 0 0 0 7	1 3
0 0 0 0 8	1 4
0 0 0 0 9	1 5
0 0 0 1 0	1 1 3
0 0 0 1 1	1 1 4
0 0 0 1 2	1 1 5
0 0 0 1 3	1 2 5
0 0 0 1 4	1 2 6
0 0 0 1 5	1 2 7
0 0 0 1 6	1 3 0
0 0 0 1 7	1 3 1

Figure 5-11. Local Troubleshooting Flowchart (Sheet 1 of 2)

OPTION 030 FREQUENCY C TROUBLESHOOTING FLOWCHART

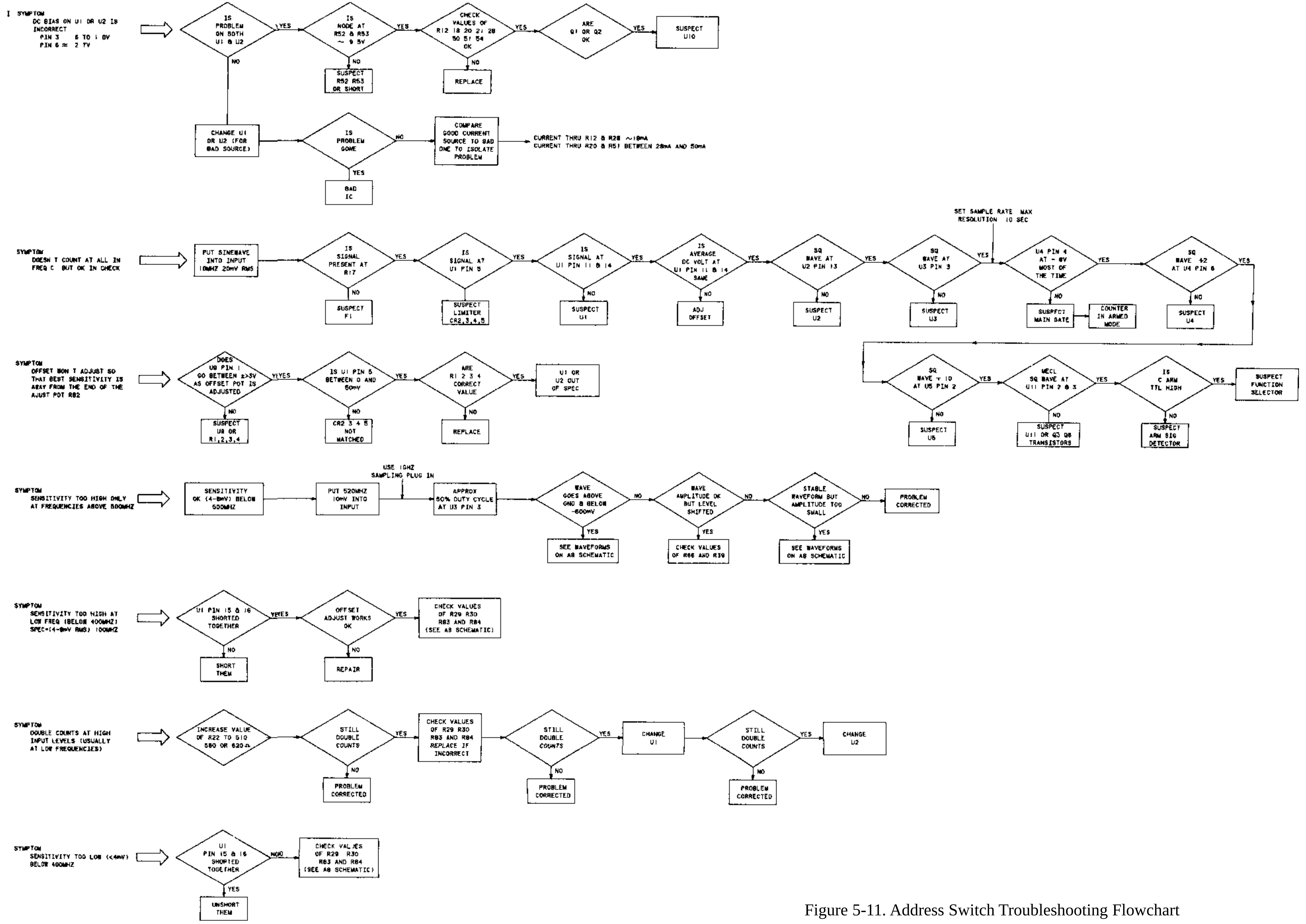


Figure 5-11. Address Switch Troubleshooting Flowchart

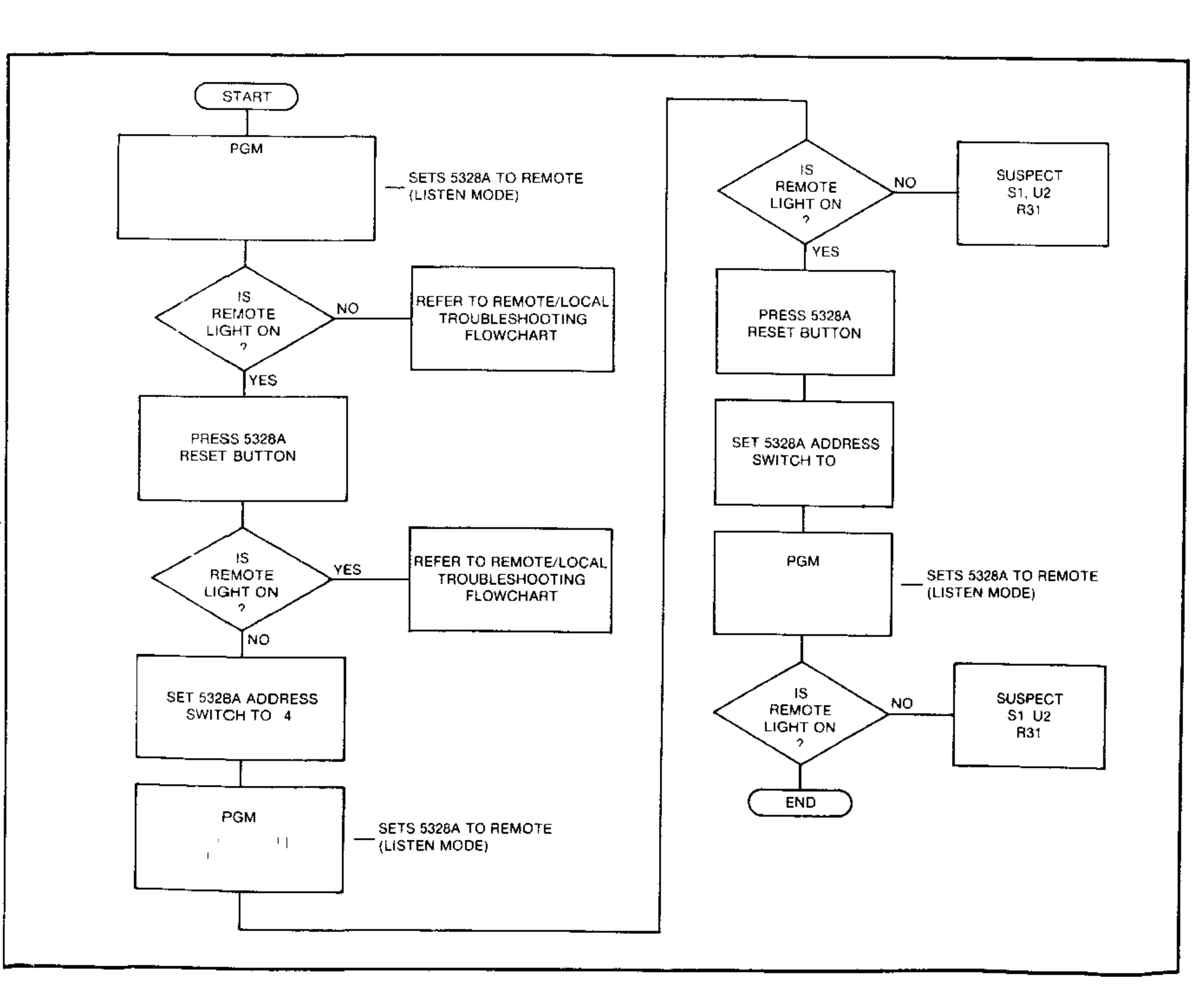


Figure 5-12. ADDRESS SWITCH Troubleshooting Flowchart

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. Table 6-7 lists parts in alphanumerical order of their reference designators and indicates the description and HP PART Number of each part, together with any applicable notes. The table includes the following information.

a. Description of part (see abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers Table 6-2.

c. Manufacturer's part number.

d. Total quantity used in the instrument (Qty column).

6-3. ORDERING INFORMATION

6-4. To obtain replacement parts, address order of inquiry to your local Hewlett-Packard Sales and Service Office (see lists at rear of this manual for addresses). Identify parts bv their Hewlett-Packard part numbers.

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

REFERENCE DESIGNATIONS

A = assembly
AT = attenuator isolator termination
B = fan, motor
BT = battery
C = capacitor
CP = coupler
CR = diode, diode thyristor, varactor
DC = directional coupler
DL = delay line
DS = annunciator, signaling device (audible or visual), lamp, LED
E = micellaneous electrical part
F = fuse
FL = filter
H = hardware
HY = circulator
J = electrical connector (stationary portion), jack
K = relay
L = coil, inductor
M = meter
MP = miscellaneous mechanical part
P = electrical connector (movable portion), plug
Q = transistor, SCR, triode thyristor
R = resistor
RT = thermistor
S = switch
T = transformer
TB = terminal board
TC = thermocouple
TP = test point
U = integrated circuit, microcircuit
V = electron tube
VR = voltage regulator, breakdown diode
W = cable, transmission path; wire
X = socket
Y = crystal unit-piezo-electric
Z = tuned cavity, tuned circuit

ABBREVIATIONS

A = ampere
ac = alternating current
ACCESS = accessory
ADJ = adjustment
A/D = analog-to-digital
AF = audio frequency
AFC = automatic frequency control
AGC = automatic gain control
AL = aluminum
ALC = automatic level control
AM = amplitude modulation
AMPL = amplifier
APC = automatic phase control
ASSY = assembly
AUX = auxiliary
avg = average
AWG = american wire gauge
BAL = balance
BCD = binary coded decimal
BD = board
BE CU = beryllium copper
BFO = beat frequency oscillator
BH = binder head
BKDN = breakdown
BP = bandpass
BPF = bandpass filter
BRS = brass
BWO = backward-wave oscillator
CAL = calibrate
ccw = counterclockwise
CER = ceramic
CHAN = channel
cm = centimeter
CMO = coaxial
COEF = coefficient
COM = common
COMP = composition
COMPL = complete
CONN = connector
CP = cadmium plate
CRT = cathode-ray tube
CTL = complementary transistor logic
CW = continuous wave
cw = clockwise
D/A = digital-to-analog
dB = decibel
dBm = decibel referred to 1 mW
dc = direct current
deg = degree (temperature interval or difference)
° = degree (plane angle)
°C = degree Celsius (centrigrade)
°F = degree Fahrenheit
°K = degree Kelvin
DEPC = deposited carbon
DET = detector
diam = diameter
DIA = diameter (used in parts list)
DIFF AMPL = differential amplifier
div = division
DPDT = double-pole, double-throw
DR = drive
DSB = double sideband
DTL = diode transistor logic
DVM = digital voltmeter
ECL = emitter coupled logic

ABBREVIATIONS (CONTINUED)

EMF	= electromotive force
EDP	= electronic data processing
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farad
FET	= field-effect transistor
F/F	= flip-flop
FH	= flat head
FOL H	= fillister head
FM	= frequency modulation
FP	= front panel
FREQ	= frequency
FXD	= fixed
g	= gram
GE	= germanium
GHz	= gigahertz
GL	= glass
GND	= ground(ed)
H	= henry
h	= hour
HET	= heterodyne
HEX	= hexagonal
HD	= head
HDW	= hardware
HF	= high frequency
HG	= mercury
HI	= high
HP	= Hewlett-Packard
HPF	= high pass filter
HR	= hour (used in parts list)
HV	= high voltage
Hz	= Hertz
IC	= integrated circuit
ID	= inside diameter
IF	= intermediate frequency
IMPG	= impregnated
in	= inch
INCD	= incandescent
INCL	= include(s)
INP	= input
INS	= insulation
INT	= internal
kg	= kilogram
kHz	= kilohertz
kΩ	= kilohm
kV	= kilovolt
lb	= pound
LC	= inductance-capacitance
LED	= light-emitting diode
LF	= low frequency
LG	= long
LH	= left hand
LIM	= limit
LIN	= linear taper (used in parts list)
lin	= linear
LK WASH	= lockwasher
LO	= low, local oscillator
LOG	= logarithmic taper (used in parts list)
log	= logarithm(ic)
LPF	= low pass filter
LV	= low voltage
m	= meter (distance)
mA	= milliampere
MAX	= maximum
MΩ	= megohm
MEG	= meg (10^6) (used in parts list)
MET FLM	= metal film
MET OX	= metal oxide
MF	= medium frequency; microfared (used in parts list)
MFR	= manufacturer
mg	= milligram
MHz	= megahertz
mH	= millihenry
mho	= mho
MIN	= minimum
min	= minute (time)
′	= minute (plane angle)
MINAT	= miniature
mm	= millimeter
MOD	= modulator
MOM	= momentary
MOS	= metal-oxide semi-conductor
ms	= millisecond
MTG	= mounting
MTR	= meter (indicating device)
mV	= millivolt
mVac	= millivolt, ac
mVdc	= millivolt, dc
mVpk	= millivolt, peak
mVp-p	= millivolt, peak-to-peak
mVrms	= millivolt, rms
mW	= milliwatt
MUX	= multiplex
MY	= mylar
μA	= microampere
μF	= microfarad
μH	= microhenry
μmho	= micromho
μs	= microsecond
μV	= microvolt
μVac	= microvolt, ac
μVdc	= microvolt, dc
μVpk	= microvolt, peak
μVp-p	= microvolt, peak-to-peak
μVrms	= microvolt, rms
μW	= microwatt
nA	= nanoampere
NC	= no connection
N/C	= normally closed
NE	= neon
NEG	= negative
nF	= nanofarad
NI PL	= nickel plate
N/O	= normally open
NOM	= nominal
NORM	= normal
NPN	= negative-positive-negative
NPO	= negative-positive zero (zero temperature coefficient)
NRFR	= not recommended for field replacement
NSR	= not separately replaceable
ns	= nanosecond
nW	= nanowatt
OBD	= order by description
OD	= outside diameter
OH	= oval head
OP AMPL	= operational amplifier
OPT	= option
OSC	= oscillator
OX	= oxide
oz	= ounce
Ω	= ohm
P	= peak (used in parts list)
PAM	= pulse-amplitude modulation
PC	= printed circuit
PCM	= pulse-code moudulation, pulse-count modulation
PDM	= pulse-duration modulation
pF	= picofarad
PH BRZ	= phosphor bronze
PHL	= Phillips
PIN	= positive-intrinsic-negative
PIV	= peak inverse voltage
pk	= peak
PL	= phase lock
PLO	= phase lock oscillator
PM	= phase modulation
PNP	= positive-negative-positive
P/O	= part of
POLY	= polystyrene
PORC	= porcelain
POS	= positive; position(s) (used in parts list)
POSN	= position
POT	= potentiometer
p-p	= peak-to-peak
PP	= peak-to-peak (used in parts list)
PPM	= pulse-position modulation
PREAMPL	= preamplifier
PRF	= pulse-repetition frequency
PRR	= pulse repetition rate
ps	= picosecond
PT	= point
PTM	= pulse-time modulation
PWM	= pulse-width modulation
PWV	= peak working voltage
RC	= resistance capacitance
RECT	= rectifier
REF	= reference
REG	= regulated
REPL	= replaceable
RF	= radio frequency
RFI	= radio frequency interference
RH	= round head; right hand
RLC	= resistance-inductance-capacitance
RMO	= rack mount only
rms	= root-mean-square
RND	= round
ROM	= read-only memory
R&P	= rack and panel
RWV	= reverse working voltage
S	= scattering parameter
s	= second (time)
″	= second (plane angle)
S-B	= slow-blow (fuse (used in parts list)
SCR	= silicon controlled rectifier; screw
SE	= selenium
SECT	= sections
SEMICON	= semiconductor
SHF	= superhigh frequency
SI	= silicon
SIL	= silver
SL	= slide
SNR	= signal-to-noise ratio
SPDT	= single-pole, double-throw
SPG	= spring
SR	= split ring
SPST	= single-pole, single-throw
SSB	= single sideband
SST	= stainless steel
STL	= steel
SQ	= square
SWR	= standing-wave ratio
SYNC	= synchronize
T	= timed (slow-blow fuse)
TA	= tantalum
TC	= temperature compensating
TD	= time delay
TERM	= terminal
TFT	= thin-film transistor
TGL	= toggle
THD	= thread
THRU	= through
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TSTR	= transistor
TTL	= transistor-transistor logic
TV	= television
TVI	= television interference
TWT	= traveling wave tube
U	= micro (10^{-6}) (used in parts list)
UF	= microfarad (used in parts list)
UHF	= ultrahigh frequency
UNREG	= unregulated
V	= volt
VA	= voltampere
Vac	= volts ac
VAR	= variable
VCO	= voltage-controlled oscillator
Vdc	= volts dc
VDCW	= volts dc, working (used in parts list)
V(F)	= volts, filtered
VFO	= variable-frequency oscillator
VHF	= very-high frequency
Vpk	= volts peak
Vp-p	= Volts peak-to-peak
Vrms	= volts rms
VSWR	= voltage standing wave ratio
VTO	= voltage-tuned oscillator
VTVM	= vacuum-tube voltmeter
V(X)	= volts, switched
W	= watt
W/	= with
WIV	= working inverse voltage
WW	= wirewound
W/O	= without
YIG	= yttrium-iron-garnet
Zo	= characteristic impedance

NOTE

All abbreviations in the parts list will be in upper case

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

6-5. HP PART NUMBER ORGANIZATION

6-6. Following is a general description of the HP part number system.

6-7. Component Parts and Materials

6-8. Generally, the prefix of HP part numbers identifies the type of device. Eight digit part numbers are used, where the four-digit prefix identifies the type of component, part, or material and the four-digit suffix indicates the specific type. Following is a list of some of the more commonly used prefixes for component parts. The list includes HP manufactured parts and purchased parts.

Prefix	Component/Part/Material
0121-	Capacitors, Variable (mechanical)
0122-	Capacitors, Voltage Variable (semiconductor)
0140-	Capacitors, Fixed
0150-	Capacitors, Fixed Non-Electrolytic
0160-	Capacitors, Fixed
0180-	Capacitors, Fixed Electrolytic
0330-	Insulting Materials
0340-	Insulters, Formed
0370-	Knobs, Control
0380-	Spacers and Standoffs
0410-	Crystals
0470-	Adhesives
0490-	Relays
0510-	Fasteners
0674- thru 0778-	Resistors, Fixed (non wire wound)
0811- thru 0831-	Resistors (wire wound)
1200-	Sockets for components
1205-	Heat Sinks
1250-	Connectors (RF and related parts)
1251-	Connectors (non RF and related parts)
1410-	Bearings and Bushings
1420-	Batteries
1820-	Monolithic Digital Integrated Circuits
1826-	Monolithic Linear Integrated Circuits
1850-	Transistors, Germanium PNP
1851-	Transistors, Germanium NPN
1853-	Transistors, Silicon PNP
1854-	Transistors, Silicon NPN
1855-	Field-Effect-Transistors
1900- thru 1912-	Diodes
1920- thru 1952-	Vacuum Tubes
1990-	Semiconductor Photosensitive and Light-Emitting Diodes
3100- thru 3106-	Switches
8120-	Cables
9100	Transformers, Coils, Chokes, Inductors, and Filters

6-9. For example, 1854-0037, 1854-0221, and 1851-0192 are all NPN transistors. The first two are silicon and the last is germanium.

6-10. General Usage Parts

6-11. The following list gives the prefixes for HP manufactured parts used in several instruments, e.g., side frames, feet, top and bottom covers, etc. These are eight-digit part numbers with the four-digit prefix identifying the type of parts as shown below:

Type of Part	Prefix
Sheet Metal	5000- to 5019-
Machined	5020- to 5039-
Molded	5040- to 5059-
Assemblies	5060- to 5079-
Components	5080- to 5099-

6-12. Specific Instrument Parts

6-13. These are HP manufactured parts for use in individual instruments or series of instruments. For these parts, the prefix indicates the instrument and the suffix indicates the type of parts. For example, 05328-60001 is an assembly used in the 5328A. Following is a list of suffixes commonly used.

Type of Part	P/N Suffix
Sheet Metal	-00000 to -00499
Machined	-20000 to -20499
Molded	-40000 to -40499
Assemblies	-60000 to -60499
Components	-80000 to -80299
Documentation	-90000 to -90249

6-14. FACTORY SELECTED PARTS

6–15. Some of the values in the parts lists are selected during manufacture to meet circuit requirements. These parts are marked with an asterisk (*) in the parts list and schematic diagrams, with average values shown.

6-16. PART NUMBER TO NATIONAL STOCK NUMBER CROSS REFERENCE INDEX

6-17. Refer to Table 6-3 to cross reference part numbers to National Stock Numbers.

TABLE 6-1. REPLACEABLE PARTS

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A1	05328-60028	9	1	MOTHER (MAIN) BOARD, SERIES 1804	28480	05328-60028
A1C1				NOT ASSIGNED		
A1C2				NOT ASSIGNED		
A1C3	0180-1735	2	1	CAPACITOR-FXD .22UF+-10% 35VDC TA	56389	150D224X9035A2
A1C4	0160-0161	4	1	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A1C5*	0180-0106	9	2	CAPACITOR-FXD 60UF+-20% 6VDC TA *FACTORY SELECTED PART	56289	150D606X0006B2
A1C6	0140-0177	0	1	CAPACITOR-FXD 400PF +-1% 300VDC MICA	72136	DM15F401F0300WV1CR
A1C7	0170-0024	9	1	CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A1C8	0180-0230	0	3	CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C10	0160-0314	9	1	CAPACITOR-FXD .01UF +-5% 100VDC POLYE	84411	663UW10354W2
A1C29	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C30	0160-0153	4	2	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A1C31	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X0050A2
A1C32	0180-0106	9		CAPACITOR-FXD 6UF+-20% 6VDC TA	56289	150D606X0006B2
A1C33	0160-2055	9	17	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C34	0180-0210	6	6	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C35	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C36	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C37	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C39	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C40	0180-0155	8	6	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C41	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C42	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C43	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C44	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C45	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C46	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A1C47				NOT ASSIGNED		
A1C48	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C49	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1C50				NOT ASSIGNED		
A1C51				NOT ASSIGNED		
A1C52	0180-0155	8		CAPACITOR-FXD 2.2UF=-20% 20VDC TA	56289	150D225X0020A2
A1C53	0180-0155	8		CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A1CR1	1901-0040	1	13	DIODE-SWICHING 30V 50MA 2NS DO.35	28480	1901-0040
A1CR3	1910-0016	0	2	DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A1CR4	1902-0031	2	1	DIODE-ZNR 12.7V 5% DO-7 PD=.4W TC=+.061%	28480	1902-0031
A1CR5	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR8	1902-3082	9	1	DIODE-ZNR 4.64V 5% DO-7 PD=.4W TC=.23%	28480	1902-3082
A1CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR11	1901-0040	1		SIODE-WITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR15	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A1CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1Q1	1854-0071	7	5	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q4	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q5	1854-0071	7		TRANSISTOR NPN PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1854-0092	2	1	TRANSISTOR NPN SI PF=200MW FT-600MHZ	28480	1854-0092
A1Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1R1	0683-2715	6	7	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R2	1810-0055	5	5	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R3	0683-2725	8	4	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R4*	0683-3355	2	1	RESISTOR 3.3M 5% .25W FC TC=-900/+1100 *FACTORY SELECTED PART	01121	CB3355
A1R5	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R6	0683-3315	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R7	0683-1035	1	23	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R8	0683-4725	2	5	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R9	0683-1525	4	1	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R10	0683-1025	9	21	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R11	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R12	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R13	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R14	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A1R15	1810-0041	9	2	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0041
A1R16	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R17	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R19	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R23	0683-2015	9	1	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A1R27	0757-0928	6	1	RESISTOR 1.5K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1501-G
A1R28	1810-0055	5		NETWORK-RES 9-ON-SIP .15-PIN-SPCG	28480	1810-0055
A1R29	0757-0952	6	1	RESISTOR 15K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1502-G
A1R30	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R32	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R33	0683-1035	1		RESISOTOR 10K 5% .25W TC=-400/+700	01121	CB1035
A1R34	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R35	0683-5115	6	5	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A1R36	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R37	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A1R38	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R39	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R40	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R41	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R42	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R43	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R44	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R45	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R46	0683-1545	8	1	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A1R48	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R52	0683-5635	5	1	RESISOTR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A1R55	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R56	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A1R57	0683-6815	5	4	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A1R58	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R59	0683-5605	9	9	RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R60	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R61	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R62	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R63	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R64	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R65	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R66	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/=500	01121	CB5605
A1R67	0683-5605	9		RESISTOR 56 5% .25W FC TC=-400/+500	01121	CB5605
A1R68	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R69	0757-0938	8	1	RESISTOR 3.9K 2% .125W F TC=0+-100	24546	C4-1/8-TO-3901-G
A1R70	0757-0950	4	1	RESISTOR 12K 2% .125W F TC=0+-100	24546	C4-1/8-TO-1202-G
A1R71	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-TO-3161-F
A1R72	0757-0931	1	1	RESISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-TO-2001-G
A1R73	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R74	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R75	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/=700	01121	CB1035
A1R78	0683-4315	6	3	RESISTOR 430 5% .25W FC TC=-400/+700	01121	CB4315
A1R80	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1S1				NOT ASSIGNED		
A1S2				NOT ASSIGNED		
A1S3	3101-1977	1	1	SWITCH-SL DPDT-NS SUBMIN .5A 125VAC PC	28480	3101-1977
A1U1	1820-0055	6	2	IC CNTR TTL DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U2	1820-1056	9	1	IC SCHMITT-TRIG TTL NAND QUAD 2-INP	01295	SN74132N
A1U3	1820-0175	1	1	IC INV TTL HEX 1-INP	01295	SN7405N
A1U4*	1820-0632	5	1	IC MISC	28480	1820-0632
				*FACTORY SELECTED PART		
A1U5	1820-0513	1	2	IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U6	1820-0282	1	4	IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U7	1820-0511	9	1	IC GATE TTL AND QUAD 2-INP	01295	SN7408N
A1U8	1820-0174	0	6	IC INV TTL HEX 1-INP	01295	SN7404N
A1U9	1820-0661	0	2	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U10	1820-1143	5	1	IC CNTR TTL DECD SYNCHRO	27014	DM8552N
A1U11	1820-0301	5	5	IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U12	1820-0634	7	1	IC CNTR MOD DECD	28480	1820-0634
A1U13	1820-0269	4	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U14	1820-0513	1		IC GATE TTL AND QUAD 2-INP	01295	SN7409N
A1U16	1820-0537	9	1	IC SCHMITT-TRIG TTL NAND DUAL 4-INP	01295	SN7413N
A1U17	1820-0068	1	1	IC GATE TTL NAND TPL 3-INP	01295	SN74010N
A1U18	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A1U19	1820-0077	2	1	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A1U20	1820-0055	6		IC CNTR DECD SYNCHRO POS-EDGE-TRIG	01295	SN7490AN
A1U21	1820-0633	6	1	IC MISC	28480	1820-0633
A1U22	1820-0269	4		IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A1U23	1820-0328	6	2	IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A1U24	1820-0282	1	2	IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U25	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A1U26	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U27	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U28	1820-0538	0	2	IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U29	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U30	1820-0282	1		IC GATE TTL EXCL-OR QUAD 2-INP	01295	SN7486N
A1U31	1820-0301	5		IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A1U32	1820-0538	0		IC GATE TTL NOR DUAL 4-INP	01295	SN7423N
A1U33	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A1U34	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A1U35	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A1U36	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A1U37	1816-2251	9	1		28480	1816-2251
A1U38	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A1U39	1820-0214	9	1	IC DCDR TTL BCD-TO-DEC 4-TO-10-LINE	02395	SN7442N
A1U40	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A1U41	1820-0914	6	1	IC DCDR TTL BCD-TO-7-SEG 4TO-7-LINE	047513	MC8307P
A1XU4	1200-0525	1	1	SOCKET-IC 20-CONT DBL STRP DIP-SLDR	28480	1200-0525
A1XU12	1200-0473	8	2	SCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
A1XU21	1200-0473	8		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-0473
				A1 MISCELLANEOUS		
	0360-0124	3	2	CONNECTOR-SGL XONT PIN .04-IN-BSC-32 RND	28480	0360-0124
	0380-0640	0	1	STANDOFF-RND .5-IN-LG 6-32THD .25-IN-OD	0000	ORDER BY DESCRIPTION
	1200-0549	9	4	SOCKET-IC 14-CONT STRIP0 DIP-SLDR	28480	1200-0549
	1251-2026	8	1	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	28480	1251-2026
	1251-2035	9	2	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
	8159-0003	0	2	WIRE 22WG W PVC 1X22 80C	28480	8159-0005
A2	05328-60035	8	1	ASSEMBLY,POWER SUPPLY (SERIES 1808) OPTION 096	28480	05328-60035
A2C1	0180-2842	4	2	CAPCITOR-RXD 450 0UF+20% 35VDC AL	28480	0180-2842
A2C2	0180-2842	4		CAPACITOR-FXD 4500UF+-20% 35 VDC AL	28480	0180-2842
A2C3#	0160-0576	5	7	CAPACITOR-FXD .1UF +-20% 50VDC CER # ADDED IF NEEDED,NOT IN ALL INSTRUMENTS	28480	0160-0576
A2C4#	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER #ADDED IF NEEDE,NOT IN ALL INSTRUMENTS	28480	0160-0576
A2C5*	0160-2203	9	1	CAPACITOR-FXD 91PF +-5% 300VDC MICA 0+70 *FACTORY SELECTED PART	28480	0160-2203
A2C6*	0160-0945	2	1	CAPACITOR-FXD 910PF +-5% 100VDC MICA *FACTORY SELECTED PART	28480	0160-0945
A2C7	0180-0562	1	1	CAPACITOR-FXD 33UF +-20% 10VDC TA	56289	196D336X0010KA1
A2C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C9	0180-2827	5	2	CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A2C10	0180-2827	5		CAPACITOR-FXD 47UF+100-10% 40VDC AL	28480	0180-2827
A2C11	0180-2832	2	2	CAPACITOR-FXD 1000UF+100-10% 12VDC AL USE EXACT REPLACEMENT PART	28480	0180-2832
A2C12	0180-2832	2		CAPACITOR-FXD 1000UF+100-10% 12VDC AL USE EXACT REPLACEMENT PART	28480	0180-2832
A2C13	0180-0418	6	2	CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A2C14	0180-0418	6		CAPACITOR-FXD 1UF+-20% 35VDC TA	28480	0180-0418
A2C15	0140-0209	9	2	CAPACITOR-FXD 5PF +-10% 500VDC MICA #ADDED IF NEEDED,NOT IN ALL INSTRUMENTS	72136	DM15C050K0500WV1CR
A2C16	0140-0209	9		CAPACITOR-FXD 5PF +-10% 500VDC MICA	72136	DM15C050K0500WV1CR
A2C17	0180-0587	0	2	CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C18	0180-0587	0		CAPACITOR-FXD 47UF+100-10% 25VDC AL	56289	672D476H025CC5B
A2C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C20#	0160-3879	7	3	CAPACITOR-FXD .01UF +-20% 100VDC CER #ADDED IF NEEDED,NOT IN ALL INSTRUMENTS	28480	0160-3879
A2C21	0160-0128	3	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	2840	0160-0128
A2C22	0160-0128	3		CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A2CR1	1902-0774	0	2	DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR2	1902-0774	0		DIODE-ZNR 12.1V 10% DO-15 PD=1W	28480	1902-0774
A2CR3	1901-1086	7	2	DIODE-PWR RECT 50V 5A 200NS	04713	MR820
A2CR4	1901-1086	7		DIODE-PWR RECT 50CT 50V05A 200NS	04713	MR820
A2CR5				NOT ASSIGNED		
A2CR6				NOT ASSIGNED		
A2CR7	1902-0522	6	2	DIODE-ZNR 1N53408 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR8	1902-0522	6		DIODE-ZNR 1N53408 6V 5% PD=5W IR=1UA	04713	1N5340B
A2CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO=35	28480	1901-0040
A2CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	298480	1901-0040
A2CR11	1902-0632	9	2	DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A2CR12	1902-0632	9		DIODE-ZNR 1N5354B 17V 5% PD=5W TC=+75%	04713	1N5354B
A2CR13	1901-0638	3	1	DIODE-FW BRDG 100V 4A	04713	MDA-970-2

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A2F1	2110-0002	9	2	FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC	75915	312002
A2F2	2110-0002	9		FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC	75915	312002
A2L1	9100-3017	8	2	INDUCTOR:FXD: 300UH AT 5A DC	28480	9100-3017
A2L2	9100-3017	8		INDUCTOR:FXD: 300UH AT 5A DC	28480	9100-3017
A2L3	9100-3139	5	1	COIL 75UH 15% .5DX.875LG=NOM	28480	9100-3139
A2Q1	1853-0363	8	2	TRANSISTOR PNP SI PD=50W	03508	X45H281
A2Q2	1854-0635	9	3	TRANSISTOR NPN SI PD=50W	03508	D44H5
A2Q3	1853-0326	3	1	TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A2Q4	1854-0634	8	1	TRANSISTOR NPN SI PD=1W FT=MHZ	04713	MPS-U01
A2Q5	1854-0492	6	2	TRANSISTOR NPN SI PD=250MHZ	28480	1854-0492
A2Q6	1853-0016	8	2	TRANSISTOR PNP SI TO -92 PD=300MW	28480	1853-0016
A2Q7	1853-0363	8		TRANSISTOR PNP SI PD=50W	03508	X45H281
A2Q8	1854-0635	9		TRANSISTOR NPN SI PF=50W	03508	D44H5
A2Q9	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A2Q10	1853-0016	8		TRANSISTOR PNP SI TO=92 PD=300MW	28480	1853-0016
A2Q11	1854-0635	9		TRANSISTOR NPN SI PD=50W	03508	D44H5
A2R1	0761-0026	4	2	RESISTOR 220 5% 1W MO TC=0+-200	28480	0761-0026
A2R2	0761-0026	4		RESISTOR 220 5% 1W MO TC=0+-200	28480	0761-0026
A2R3	0683-1015	7	3	RESISTOR 100 5% .25W FC TC=400/+500	01121	CB1015
A2R4	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R5	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R6	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R7	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R8	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R9	0698-3620	5	2	RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R10	0698-3620	5		RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A2R11	0683-8245	9	1	RESISTOR 820K 5% .25W FC TC=-800/+900	01121	CB8245
A2R12	0683-1055	5	1	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A2R13	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R14	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R16	0698-3160	8	1	RESISTOR 31.6K 1%.125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A2R17	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A2R18	0757-0454	3	1	RESISTOR 33.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3322-F
A2R19	0683-1025	9		RESISTOR 4K 5% .25W FC TC=-400/+600	01121	CB1025
A2R20	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R21	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R22	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R23	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R24	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R25	0757-0280	3	3	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R26	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R27	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A2R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R29	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R30	0683-1135	2	1	RESISTOR 11K 5% .25W FC TC=-400/+800	01121	CB1135
A2R31	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A2R32	0811-3050	7	1	RESISTOR .75 5% .5W PW TC=0+-150	75042	BW20-1-3/4-J
A2R33				NOT ASSIGNED		
A2R34	0811-1340	4	2	RESISTOR 1 5% 5W PW TC=0+-50	28480	0811-1340
A2R35	0811-1340	4		RESISTOR 1 5% 5W PW TC=0+-50	28480	0811-1340
A2R36	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2R37	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A2U1	1826-0065	0	2	IC 311 COMPARATOR 8-DIP-P	01295	SN72311P
A2U2	1826-0065	0		IC 311 COMPARATOR 8-DIP-P	01295	SN72311P
A2U3	1820-0477	6	2	IC OP AMP 8-DIP-P	207014	LM301AN
A2U4	1820-0477	6		IC O AMP 8DIP-P	27014	LM301AN
A2U5	1820-0439	0	2	IC V RGLTR 14-DIP-P	07263	723PC
A2XF1	2110-0269	0	4	FUSEHOLDER-CLIP TYPE.250-FUSE	28480	2110-0269
A2XF2	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A2XQ1	1251-3246	6	5	CONNECTOR 3-PIN F	28480	1251-3240
A2XQ2	1251-3246	6		CONNECTOR 3-PIN F	28480	1251-3246
A2XQ7	1251-3246	6		CONNECTOR 3-PIN F	28480	1251-3246
A2XQ6	1251-3246	6		CONNECTOR 3-PIN F	28480	1251-3246
A2XQ11	1251-3246	6		CONNECTOR 3-PIN F	28480	1251-3246
A3	05328-60027	8	1	OSCILLATOR SUPPORT (SERIES 1744)	28480	05328-60027
A3A1	10544-60011	3	1	CRYSTAL OSCILLATOR ASSEMBLY	28480	10544-60011
A3C1	0180-1746	5	1	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A3C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C3	0160-3877	5	1	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A3C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C5	0180-0116	1	1	CAPACITOR-FXD 6.8UF+10% 35VDC TA	56289	150D685X9035B2

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A3C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C7	0160-3876	4	1	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A3C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C11	0140-0221	5	2	CAPACITOR-FXD 220PF +-1% 300VDC MICA	72136	DM15F221F0300WV1C
A3C12	0121-0180	5	2	CAPACITOR-V TRMR-CER 15-60PF 200V PC-MTG	52763	304324 15/60PF N1500
A3C13	0140-0221	5		CAPACITOR-FXD 220PF +-1% 300VDC MICA	72136	DM15F221F0300WV1C
A3C14	0160-3875	3	1	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A3C15	0121-0180	5		CAPACITOR-V TRMR-CER 15-60PF 200V PC-MTG	52763	304324 15/60PF N1500
A3C16	0160-3456	6	1	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A3C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C18	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3CR1	1902-0579	3	1	DIODE-ZNR 5.11V 5% DO=15 PD=1W TC=-.009%	28480	1902-0579
A3CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS D0-35	28480	1901-0040
A3L1	9140-0131	5	1	COIL-MLD 10MM 5% Q=80 .24DX.74LG-NOM	28480	9140-0131
A3L2	9100-1788	6	1	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A3L3	9140-0096	1	2	COIL-MLD 1UH 10% Q=50 .155DX.375LG-NOM	28480	9140-0096
A3L4	9140-0096	1		COIL-MLD 1UH 10% Q=50 .155DX.375LG-NOM	28480	9140-0096
A3Q1	1854-0215	1	5	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q3	1853-0036	2	1	TRANSISOTR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A3R1						
A3R2	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R3	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R5	0683-1225	1	1	RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A3R6	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R7	0683-0475	1	1	RESISTOR 4.7 5% .25W FC TC=-400/+500	01121	CB47G5
A3R8	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R9	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R10	0683-4715	0	1	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A3R11	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A3R12	0683-1005	5	1	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R13	0811-1856	7	1	RESISTOR 250 5% 5W PW TC=0+-20	28480	0811-1856
A3R14	2100-3103	6	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A3R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R17	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R18	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R19	0698-3136	8	1	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A3U1	1820-1490	5	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS90N
A3U2	1820-1428	9	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS158N
A3U3	1820-0439	0		IC V RGLTR 14-DIP-P	07263	723PC
A3U4	1820-1052	5	2	IC XL TR ECL/TTL ECL-TO-TTL QUAD 2-INP	04913	MC10125L
A3U5	1826-0276	5	1	IC 78L05A V RGLTR TO-92	04713	MC78L05ACP
A3W1	05328-60115	5	1	CABLE ASSEMBLY, OSCILLATOR	28480	05328-60115
	8120-0229	9	1	CABLE-COAX 50-OHM 29PF/FT	28480	8120-0229
	0890-0029	0	1	TUBING-HS .187-D/.093-RCVD .02-WALL	28480	0890-0029
	1250-0824	8	1	CONNECTOR-RF SMC FEM UNMTD 50-OHM	28480	1250-0824
	1250-0870	4	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
	1250-0952	3	1	CONTACT-RF CONN/TNCIFEM CTR	24931	C232-2
	1250-0957	8	1	BUSHING RF CONN BNC/TNCI FOR INTL	24931	CS 105-2
	1250-0960	3	1	SLEEVE-RF CONN SER BNC/TNC	28480	1250-0960
	1250-0964	7	1	NUT-RF CONN BNC/TNCI CLAMP NUT FOR	24931	N126-2
				A3 MISCELLANEOUS		
	0380-0310	1	5	STANDOFF-RVT-ON .75-IN-LG 6-32THD	0000	ORDER BY DESCRIPTION
	1250-0835	1	1	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2ROWS	28480	1251-2035
	8159-0005	0		WIRE 22AWG W PVC 1X22 80C	28480	8159-0005
A4	05328-60005	2	1	FUNCTION SELECTOR	28480	05328-60005
A4C1				NOT ASSIGNED		
A4C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C3	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28460	0160-4084
A4C4	0140-0215	7	2	CAPACITOR-FXD 80PF +-2% 300VDC MICA	72136	DM15E800G0300WV1CR
A4C5	0140-0215	7		CAPACITOR-FXD 80PF +-2% 300VDC MICA	72136	DM15E800G0300WV1CR
A4C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C7	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A4C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C9	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	56289	150D335X0015A2
A4C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A4C11	0160-0342	3	1	CAPACITOR-FXD 800PF +-1% 300VDC MICA	28480	0160-0342
A4C12	0140-0214	6	1	CAPACITOR-FXD 60PF +-5% 300VDC MICA	72136	DM15E600J0300WV1CR
A4C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C16	0140-0202	2	1	CAPACITOR-FXD 15PF +-5% 500VDC MICA	72136	DM15C150J0500WV1CR
A4C17	0160-0153	4		CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A4Q1	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A4Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A4Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A4R1	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R2	0683-1315	0	3	RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R3	0683-8205	1	3	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A4R4	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/=600	01121	CB5115
A4R5	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R6	0683-2025	1	4	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R7	0683-1815	5	7	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R8	0683-2025	1		RESOSTPR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R9	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+300	01121	CB1815
A4R10	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R11	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R12	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A4R13	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R14	0683-1825	7	11	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R15	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A4R16	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R17	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R18	0683-1815	5		RESISTOR 180 55 .25W FC TC=-400/+600	01121	CB1815
A4R19	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R20	0683-8205	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A4R21	0683-1315	0		RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R22	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R23	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R24	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R26	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A4R27	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A4R28	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A4R29	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R30	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R31	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R32	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R33	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A4R34	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R35	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A4R36	0683-8205	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A4R37	0683-1315	0		RESISTOR 130 5% .25W FC TC=-400/+600	01121	CB1315
A4R38	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A4R39	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A4R40	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A4R41	0683-6815	5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A4R42	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R43	1810-0041	9		NETWORK-RES 9-PIN 81P .15-PIN-SPCG	28480	1810-0041
A4R44	1810-0080	6	1	NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080
A4R45	0698-5103	3	1	RESISTOR 430 5% .125W CC TC=-330/+800	01121	BB4315
A4R46	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4U1	1820-1225	4	1	IC FF ECL D-M/8 DUAL	04713	MC10231P
A4U2	1820-1052	5		IC XLTR ECL/TTL ELC-TO-TTL QUAD 2-INP	04713	MC10125L
A4U3	1820-0629	0	2	IC FF TTL 8 J-K NEG-EDGE-TRIG	01295	SN748112N
A4U4	1820-0629	0		IC FF TTL 8 J-K NEG-EDGE-TRIG	01295	SN74S112N
A4U5	1820-0622	3	1	IC MUXR/DATA-SEL TTL 8-TO-1-LINE 8INP	01295	SN74151AN
A4U6	1820-0829	2	1	IC MUXR/DATA-SEL ECL 8-TO-1-LINE 8-INP	04713	MC10164L
A4U7	1820-0809	8	1	IC RCVR ECL LINE RCVR QUAD 2-INP	04713	MC10115P
A4U8	1820-0802	1	1	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A4U9	1820-0328	6		IC GATE TTL NOR QUAD 2-INP	01295	SN7402N
A4U10	1820-0074	9	1	IC GATE TTL AND-OR-INV 2-INP	01295	SN7454N
				A4 MISCELLANEOUS		
	1480-0116	8	1	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	4040-0752	9	1	EXTRACTOR-PC BOARD YEL POLYC	28480	4040-0752
A5				NOT ASSIGNED		
A6				NOT ASSIGNED		
A7				NOT ASSIGNED		

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A8	05328-60032 5	1	"C" CHANNEL INPUT (SERIES 1736)	28480	05328-60032
A8C1	0160-4084 8	6	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C2	0180-0428 8	16	CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C3	0180-0428 8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C4	0180-0155 8	1	CAPACITOR-FXD 2.2UF+-20% 20VDC TA	56289	150D225X0020A2
A8C5	0160-4084 8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C6	0180-1701 2	1	CAPACITOR-FXD 68UF+-20% 6VDC TA	56289	150D685X0006A2
A8C7	0160-2599 6	1	CAPACITOR-FXD 680PF +-10% 200VDC CER	28480	0160-2599
A8C8	0160-1084 8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C9	0160-3879 7	39	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C11	0160-3878 6	6	CAPACITOR-FXD 100PF +-20% 100VDC CER	28480	0160-3878
A8C12	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C13	0160-4084 8		CPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C14	0180-0474 4	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	28480	0180-0474
A8C15	0180-0474 4		CAPACITOR-FXD 15U+-10% 20VEDC TA	28480	0180-0474
A8C16	0160-4084 8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C17	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C18	0160-3878 6		CAPACITOR-FXD 100PF +-20% 100VDC CER	28480	0160-3878
A8C20	0160-3878 6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C21	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C22	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C23	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C24	0160-3878 6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C25	0160-4084 8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A8C26	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C27	0180-0428 8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C28	0160-2055 9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C29	0160-2055 9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C30	0160-2055 9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C31	0160-3878 6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C32	0180-0428 8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A8C33	0160-3878 6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A8C34	0160-4182 7	1	CAPACITOR-FXD .01UF +-20% 200VDC CER	51642	200-200-X7R-103M
A8CR1	1901-0050 3	6	DIODE-SWITHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR2	1901-0518 8	4	DIODE-SCHOTTKY	28480	1901-0518
A8CR3	1901-0518 8		DIODE-SCHOTTKY	28480	1901-0518
A8CR4	1901-0518 8		DIODE-SCHOTTKY	28480	1901-0518
A8CR5	1901-0518 8		DIODE-SHOTTKY	28480	1901-0518
A8CR6	1901-0535 9	4	DIODE-SCHOTTKY	28480	1901-0535
A8CR7	1901-0535 9		DIODE-SCHOTTKY	28480	1901-0535
A8CR8	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR9	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR10	1901-0535 9		DIODE-SCHOTTKY	28480	1901-0535
A8CR11	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR12	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR13	1901-0050 3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR14	1901-0535 9		DIODE-SCHOTTKY	28480	1901-0535
A8F1	2110-0301 1	1	FUSE .125 125V FAST-BLO .281X.093	28480	2110-0301
	05305-20104 1	1	FUSE HOLDER	28480	05305-20104
	05305-20105 2	1	INSULATOR	28480	05305-20105
	05305-60205 7	1	CONNECTOR ASSEMBLY, BNC	28480	05305-60205
	05305-60206 8	1	CONNECTOR ASSEMBLY,SMC	28480	05305-60206
A8L1	9100-1788 6	3	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A8L2	9100-1788 6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A8L3	9140-0137 1	1	COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A8L4	9100-1788 6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
A8L5	05303-80001 1	1	COIL, PEAKING	28480	05303-80001
A8Q1	1854-0071 7	8	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q2	1854-0071 7		TRANSISTOR NNPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q3	1854-0092 2	4	TANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A8Q4	1854-0092 2		TRANSISTOR NPN SI PF=200MW FT=600MHZ	28480	1854-0092
A8Q5	1854-0092 2		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A8Q6	1854-0092 2		TRANSISTOR NPN SI PS=200MW FT=600MHZ	28480	1854-0092
A8Q7	1854-0071 7		TRANSISTOR NPN SI P=300MW FT=200MHZ	28480	1854-0071
A8Q8			NOT ASSIGNED		
A8Q9	1853-0036 2	2	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8R1	0683-1035 1	34	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R2	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R3	0683-2715 6	7	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A8R4	0683-1055 5	5	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A8R5	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A8R6	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R7	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+600	01121	CB1215
A8R8	0683-8215	3	4	RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A8R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R10	0698-8354	2	1	RESISTOR 270 5% .125W CC TC=-330/+800	01121	BB2715
A8R11	0698-6283	2	3	RESISTOR 10 5% .125W CC TC=-120/+400	01121	BB1005
A8R12	0683-5615	1	4	RESISTOR 560 5% .25W FC TC=-400/+600	01121	CB5615
A8R12	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
A8R13	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R14	0683-8205	1	2	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A8R15	0683-1125	0	4	RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R16	0683-8215		3		RESISTOI	01121
A8R17	0757-1001	8	1	RESISTOR 56.2 1% .5W F TC=0+-100	28480	0757-1001
A8R18	0683-3015	1	2	RESISTOR 300 5% .25W FC TC=-400/+600	01121	CB3015
A8R19	0683-5125	8	6	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R20	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+600	01121	CB1215
A8R21	0683-5135	0	2	RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A8R22	0683-4715	0	2	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A8R23	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R24	0683-5125	8		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R25	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R26	0683-8205	1		RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A8R27	0683-5105	4	9	RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R28	0683-5615	1		RESISTOR 560 55 .25W FC TC=-400/+600	01121	CB5615
A8R29*	0698-7080	9	4	RESISTOR 27 5% .125W CC TC=-270/+540 *FACTORY SELECTED PART	01121	BB2705
A8R30*	0695-7080	9		RESISTOR 27 5% .125W CC TC=-270/+540 *FACTORY SELECTED PART	01121	BB2705
A8R31	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R32	0683-1125	0		RESISTOR 1.1K 5% .25W FC TC=-400/+700	01121	CB1125
A8R33	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R34	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R35	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R36	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R37	0698-3111	9	1	RESISTOR 30 5% .125W CC TC=-270/+540	01121	BB3005
A8R38	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/=540	01121	BB5105
A8R39*	0683-2025	1	11	RESISTOR 2K 5% .25W FC TC=-400/+700 *FACTORY SELECTED PART	01121	CB2025
A8R40*	0698-3378	0	7	RESISTOR 51 5% .125W CC TC=-270/+540 *FACTORY SELECTED PART	01121	BB5105
A8R41	0698-4131	5	1	RESISTOR 56 5% .125W CC TC=-270/+540	01121	BB5605
A8R42*	0683-1215	9	4	RESISTOR 120 5% .25W FC TC=-400/+600 *FACTORY SELECTED PART	01121	CB1215
A8R43	0683-1815	5	3	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A8R44	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R45	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R46	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R47	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A8R48	0683-5125	8		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R49	0683-5125	8		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R50	0683-5135	0		RESISTOR 51K 5% .25W FC TC=-400/+800	01121	CB5135
A8R51	0683-1215	9		RESISTOR 120 5% .25W FC TC=-400/+600	01121	CB1215
A8R52	0683-3315	4	7	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A8R53	0683-5615	1		RESISTOR 560 5% .25W FC TC=-400/+600	01121	CB5615
A8R54	0683-3015	1		RESISTOR 300 5% .25W FC TC=-400/+600	01121	CB3015
A8R55	0683-5125	8		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R56	0757-0965	1	1	RESISTOR 51K 2% .125W F TC=0+-100	24546	C4-1/8-T0-5102-G
A8R57*	0757-0959	3	1	RESISTOR 30K 2% .125W F TC=0+-100 *FACTORY SELECTED PART	24546	C4-1/8-T0-3002-G
A8R58	0757-0924	2	1	RESISTOR 1K 2% .125W F TC=0+-100	24546	C4-1/8-T0-1001-G
A8R59	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R60	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R61	0683-2215	1	3	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A8R62	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R63	0683-5105	4		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A8R64	0683-1815	5		RESISTOR 18005% .25W FC TC=-400/+600	01121	CB1815
A8R65	0683-4705	8	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R66	0683-1025	9	15	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A8R67	0698-3378	0		RESISTOR 51 5% .125W CC TC=-270/+540	01121	BB5105
A8R68	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A8R69	0683-2005	7	5	RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A8R70	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A8R71	0683-1025	9		RECISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A8R72	0683-2005	7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A8R73	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A8R74	1810-0080	6	7	NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A8R75	0683-1525	4	7	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A8R76	0683-5125	8		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A8R77	0683-5615	1		RESISTOR 560 5% .25W FC TC=-400/+600	01121	CB5615
A8R78	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R79	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A8R80	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R81	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A8R83*	0698-7080	9		RESISTOR 27 5% .125W CC TC=-270/+540 *FACTORY SELECTED PART	01121	BB2705
A8R84*	0698-7080	9		RESISTOR 27 5% .125W CC TC=-270/+540 *FACTORY SELECTED PART	01121	BB2705
A8R85	2100-2633	5	3	RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	30983	ET50X102
A8R86	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R87				NOT ASSIGNED		
A8R88				NOT ASSIGNED		
A8R89	0683-4745	6	1	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A8U1	1826-0084	3	1	IC WIDEBAND AMPL	28480	1826-0084
A8U2*	1826-0151	5	1	IC, AMPLIFIER	28480	1826-0151
A8U2	1826-0085	4	1	IC WIDEBAND AMPL *FACTORY SELECTED PART	28480	1826-0085
A8U3	1820-2112	0	1		28480	1820-2112
A8U4	1820-0736	0	1	IC CNTR ECL BIN DUAL	28480	1820-0736
A8U5	1820-1019	4	1	IC CNTR ECL BI-QUINARY	28480	1820-1019
A8U6	1820-1052	5	2	IC XLTR ECL/TTL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A8U7	1820-0301	5	1	IC LCH TTL D-TYPE 4-BIT	01295	SN7475N
A8U8	1820-0514	2	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A8U9	1826-0139	9	2	IC 1428 OP AMP 8-DIP-P	01928	CA1458G
A8U10	1826-0139	9		IC 1458 OP AMP 8-DIP-P	01928	CA1458G
A8U11	1820-0803	2	3	IC GATE ECL OR-NOR TPL	04713	MC10105P
A8U12	1820-0514	2		IC GATE TTL NAND QUAD 2-INP	01295	SN7426N
A8U13	1826-0419	8	1	IC 8-DIP-P	27014	LM3909N
A8W1	05328-60116	6	1	CABLE ASSEMBLY, FREQUENCY "C"	28480	05328-60116
	8120-0029	7	1	CABLE-SHLD 18AWG 2-CNDCT JGK-JKT	28480	8120-0029
	05328-60119	9	1	CABLE ASSEMBLY, TEST	28480	05328-60119
	0890-0029	0	1	TUBING-HS .187-D/.093-RCVD .02-WALL	28480	0890-0029
	1250-0824	8	1	CONNECTOR-RF SMC FEM UNMTD 50-OHM	28480	1250-0824
	1250-0833	9	1	TERMINATION-COAX CA CRP/CLP-COAX-CA FEM	28480	1250-0833
A8W2	05328-60120	2		CABLE, OVERLOAD INDICATOR	28480	05328-60120
	1200-0063	2	2	CONNECTOR-SGL CONT SKT RND	28480	1200-0063
	1990-0517	4	1	LED-VISIBLE LUM-INT-3MCD IF=20MA-MAX	28480	5082-4655
	8150-0450	1	1	WIRE 24AWG O 300 PVC 7X32 80C	28480	8150-0450
	8150-0451	2	1	WIRE 24AWG Y 300V PVC 7X32 80C	28480	8150-0451
				A8 MISCELLANEAUS		
	0380-0310	1	4	STANDOFF-RVT-ON .75-IN-LG 6-32THD	0000	ORDER BY DESCRIPTION
	1200-0475	0	81	CONNECTOR-SGL CONT SKT .016-IN-BBC-8Z	28480	1200-0475
	1251-0600	0	3	CONNECTOR-SGL CONT PIN .114-MM-BSC-8Z SQ	28480	1251-0600
	1251-2229	3	2	CONNECTOR-SGL CONT SKT .033-IN-BSC-8Z	28480	1251-2229
	1480-0116	8	3	PIN-GRV .062-IN-DOA .25-IN-LG STL	28480	1480-0116
	4040-0747	2	1	EXTRACTOR-PC BOARD GRA POLYC	28480	4040-0747
A9				NOT ASSIGNED		
A10	05328-60020	1	1	SYNCHRONIZER	28480	05328-60020
A10C1	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A10C2	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A10C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A10C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10C6	0121-0059	7	1	CAPACITOR-V TRMR-CER 2-8PF 350V PC-MTG	52763	304324 2/8PF NPO
A10C7	0160-2244	8		CAPACITOR-FXD 3PF +-.25PF 500VDC CER	28480	0160-2244
A10C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A10CR1	1902-3036	3	1	DIODE-ZNR 3.16V 5% DO-7 PD=4W TC=-.064%	28480	1902-3036
A10J1	1200-0548	8	5	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0548
A10J2	1200-0548	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A10J3	1200-0548	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A10Q1	1854-0071	7		TRANSISTORNNPN SI PD=300MW FT-200MHZ	28480	1854-0071
A10R1	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A10R2	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A10R3	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080
A10R4	0683-5115	6	11	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R5	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A10R6	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R7	0683-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R8	0683-4725	2	9	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A10R9	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R10	0683-3025	3	3	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A10R11	0683-1815	5		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A10R12	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R13	0683-9115	4	2	RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R14	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080
A10R15	0683-9115	4		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A10R16	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080
A10R17	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R18	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R19	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A10R20	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R21	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R22	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0080
A10R23	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A10R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A10R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A10R26	1810-0020	4	1	NETWORK-RES 8-PIN-SIP .125-PIN-SPCG	28480	1810-0020
A10R27	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A10R28	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10R29	0683-5115	6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A10S1	3101-1596	0	8	SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A10TP1	0360-0124	3	11	CONNECTOR-SGL CONT PIN .04-IN-SBC-8Z RND	28480	0360-0124
A10TP2	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z NRD	28480	0360-0124
A10TP3	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A10TP4	0360-0124	3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A1OU1	1820-1320	0	1	IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10216L
A1OU2	1820-1049	0	2	IC TTL NON-INV HEX	01295	SN74367N
A1OU3	1820-0802	1	5	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U4	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U5	1820-0802	1		IC GATE ECL KNOR QUAD 2-INP	04713	MC10102P
A10U6	1820-0817	8	1	IC FF ECL D-M/S DUAL	04713	MC10131P
A10U7	1816-0821	5	1	IC SN74188N 256-BIT ROM TTL	01295	SN74S188N PROGRAMMED
A10U8	1820-0833	8	2	IC LCH TTLCOM CLEAR 8-BIT	07263	9334PC
A10U9	1820-1049	0		IC BFR TTL NON-INV HEX	01295	SN74367N
A10U10	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U11	1820-1359	5	1	IC MUXR/DATA-SEL ECL 4-TO-1-LINE DUAL	14713	MC10174P
A1OU12	1820-0803	2		IC GATE ECL OR-NOR TPL	04713	MC10105P
A10U13	1820-0803	2		IC GATE ECL DR-NOR TPL	04713	MC10105P
A10U14	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A10U15	1820-0833	8		IC LCH TTL COM CLEAR 8-BIT	07263	9334PC
A10U16	1820-1245	8	1	IC DCDR TTL LS 2-TO-4 LINE DUAL 2-INP	01295	SN74LS155N
A10U17	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A10W1	05328-60114	4	1	CABLE ASSEMBLY, EXT LINE	28480	05328-60114
				A10 MISCELLANEAOUS		
	1480-0116	8		PIN-GRV .063-IN-DIA .25-IN-IN-LG STL	28480	1480-0116
	4040-0748	3	3	EXTRACTOR-PC BOARD BLK POLYC	28480	4040-0748
A11	05328-60023	4	1	DIGITAL TO ANALOG CONVERT	28480	05328-60023
A11C1	0180-0374	3	2	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A11C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C3	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A11C4	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A11C5	0160-2743	2	2	CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C6	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A11C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C11	0160-2746	2		CAPACITOR-FXD 33PF +-10% 200VDC CER	28480	0160-2743
A11C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C13	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A11C14	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A11C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A11CR1	1901-0179	7	12	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR3	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR4	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR6	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR7	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR8	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR9	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR10	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR11	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR12	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS D0-7	28480	1901-0179
A11CR13	1902-0680	7	2	DIODE-ZNR IN827 6.2V 5% DO-7 PD=.25W	24046	1N827
A11CR14	1902-0680	7		DIODE-ZNR IN827 6.2V 5% DO-7 PD=.25W	24046	1N827
A11CR15	1901-0040	1	28	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A11CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A11J1	1200-0548	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0548
A11Q1	1855-0081	1	2	TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A11Q2	1855-0416	6	2	TRANSISTOR J-FET P-CHAN D-MODE SI	28480	1855-0416
A11Q3	1855-0416	6		TRANSISTOR J-FET P-CHAN D-MODE SI	28480	1855-0416
A11Q4	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A11Q5	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A11Q6	1854-0071	7		TRANSISTOR NPN SI PD-300MW FT=200MHZ	28480	1854-0071
A11Q7	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A11R1	0683-6215	9	4	RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R2	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A11R3	0683-2015	9	4	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R4	0683-4315	6	4	RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A11R5	0698-3153	9	4	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A11R6	0683-6215	9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R7*	0698-3136	8	4	RESISTOR 17.8K 1% .125W F TC=0+-100	12546	C4-1/8-T0-1782-F
A11R7*	0698-3156	2	3	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R7*	0698-3157	3	3	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A11R7*	0757-0199	3	3	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A11R7*	0757-0447	4	3	RESISTOR 16.2K 1% .125W F TC=0+-100 *FACTORY SELECTED PART	24546	C4-1/8-T0-1622-F
A11R8	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R9	0698-3152	8	4	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A11R10	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A11R11	0698-3136	8		RESISTOR 17.8K1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A11R11	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R11	0698-3157	3		RESISTOR 19.6K 1% A.125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A11R11	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A11R11	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A11R12	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A11R13	0683-1015	7	4	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A11R14	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T03831-F
A11R15	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A11R16	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A11R17	2100-2705	2	4	RESISTOR-RRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A11R18	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A11R19	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A11R20	2100-2503	8	2	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A11R21	2100-2503	8		RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-203
A11R22	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A11R23	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A11R24	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A11R25	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A11R26	2100-2705	2		RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3009P-1-102
A11R27	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A11R28*	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A11R28*	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R28*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A11R28*	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A11R28*	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100 *FACTORY SELECTED PART	24546	C4-1/8-T0-1622-F
A11R29	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A11R30	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A11R31	0683-4315	6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A11R32	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A11R33*	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A11R33*	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A11R33*	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A11R33*	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A11R33*	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100 *FACTORY SELECTED PART	24546	C4-1/8-T0-1622-F

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A11R34	0683-2015 9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R35	0698-3153 9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A11R36	0683-6215 9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R37	0683-4315 6		RESISTOR 430 5% .25W FC TC=-400/+600	01121	CB4315
A11R38	0683-2015 9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A11R39	0683-6215 9		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A11R40	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A11R41	0757-0427 0	1	RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A11R42	0683-1525 4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A11R43	0683-1525 4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A11R44	0757-0421 4	2	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A11R45	0683-1045 3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A11R46	0683-1025 9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A11R47	0757-0421 4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A11R48	0683-1025 9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A11R49	1810-0055 5	5	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A11R50	0683-2055 7	2	RESISTOR 2M 5% .25W FC TC=-900/+100	01121	CB2055
A11R51	0683-2055 7		RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A11TP1	0360-0124 3		CONNCECTOR-SGL CONT PIN .04-IN-BSC-8Z RND	28480	0360-0124
A11TP2	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND	28480	0360-0124
A11TP3	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RNS	28480	0360-0124
A11TP4	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND	28480	0360-0124
A11TP5	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND	28480	0360-0124
A11TP6	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-8Z RND	28480	0360-0124
A11U1	1826-0059 2	2	IC 201A OP AMP TO-99	04713	MLM201AG
A11U2	1820-0693 8	1	IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A11U3	1826-0161 7	2	IC 324 OP AMP 14-DIP-P	18324	LM324-A
A11U4	1826-0059 2		IC 201A OP TO 99	04713	MLM201AG
A11U5	1820-1425 6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A11U6	1826-0161 7		IC 324 OP AMP 14-DIP-P	18324	LM324-A
A11U7	1820-0976 0	4	IC SHF-RQTR CMOS D-TYPE SERIAL-IN	0192B	CD4015AF
A11U8	1820-1265 2	6	IC MULTR CMOS	04713	MC14527BCP
A11U9	1820-1265 2		IC MULTR CMOS	04713	MC14527BCP
A11U10	1820-1265 2		IC MULTR CMOS	04713	MC14527BCP
A11U11	1820-0976 0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	01928	CD4015AF
A11U12	1820-1265 2		IC MULTR CMOS	04713	MC14527BCP
A11U13	1820-1265 2		IC MULTR CMOS	04713	MC14527BCP
A11U14	1820-1265 2		IC MULTR CMOS	04713	MC14527BCP
A11U15	1820-0976 0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	01928	CD4015AF
A11U16	1820-0976 0		IC SHF-RGTR CMOS D-TYPE SERIAL-IN	01928	CD4015AF
A11W1	05328-60111 1	2	CABLE ASSEMBLY, RF/A & B INPUT	28480	05328-60111
	8120-0229 9	2	CABLE-COAX 50-OHM 29PF/FT	28480	8120-0229
	1250-0834 0	2	TERMINALTION-COAX CA CRP/CLP-COAX-CA FEM	28480	1250-0834
	1250-0870 4	2	CONNECTOR-RF FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
	1250-0952 3	2	CONTACT-RF CONN BNC/TNCIFEMC CTR	24931	C232-2
	1250-0957 8	2	BUSHING RF CONN BNC/TNCI FOR INTL	24931	CS 105-2
	1250-0960 3	2	SLEEVE-RF CONN SER BNC/TNC	28480	1250-0960
	1250-0964 7	2	NUT-RF CONN BNC/TNCI CLAMP NUT FOR	24931	N126-2
A11W2	05328-60111 1		CABLE ASSEMBLY, RF/A & B INPUT	28480	05328-60111
	8120-0229 9		CABLE-COAX 50-OHM 29F/FT	28480	8120-0229
	1250-0834 0		TERMINATION-COAX CA CRP/CLP-COAX-CA FEM	28480	1250-0834
	1250-0870 4		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-0870
	1250-0952 3		CONTACT-RF CONN BNC/TNCIFEM CTR	24931	C232-2
	1250-0957 8		BUSHING RF CONN BNC/TNCI FOR INTL	24931	CS 105-2
	1250-0960 3		SLEVE-RF CONN SER BNC/TNC	28480	1250-0960
	1250-0964 7		NUT-RF CONN BNC/TNCI CLAMP NUT FOR	24931	N126-2
			A11 MISCELLANEOUS		
	0360-0065 1	8	TERMINAL-STUD FKD-TUR SWGFRM-MTG	28480	0360-0065
	4040-0748 3		EXTRACTOR-PC BOARD BLK POLYC	28480	4040-0748
A12	05328-60031 4	1	A & B CHANNEL INPUT	28480	05328-60031
A12C1	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C2	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C3	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C4	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C5	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C6	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C7	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C8	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C9	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C10	0160-0128 3	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A12C11	0160-0128	3		CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-0128
A12C12	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A12C13	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A12C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C15	0160-0576	5	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A12C17	0180-0415	3	2	CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	
A12C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A12C19	0180-0415	3		CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	0180-0415
A12C20	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A12C21	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A12C22	0160-3876	4	2	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A12C23	0160-4423	9	2	CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7P-471M
A12C24	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A12C25	0160-4423	9		CAPACITOR-FXD 470PF +-20% 500VDC CER	51642	200-500-X7R-471M
A12C26*	0150-0059	8	2	CAPACITOR-FXD 3.3PF +-.25PF 500VDC CER	28480	0150-0059
A12C26*	0160-2242	6	1	CAPACITOR-FXD 2.4PF +-.25PF 500VDC CER	28480	0160-2242
A12C26*	0160-2244	8	2	CAPACITOR-FXD 3PF +-.25PF 500VDC CER *FACTORY SELECTED PART	28480	0160-2244
A12C29*	0150-0059	8		CAPACITOR-FXD 3.3PF +-.25PF 500VDC CER	28480	0150-0059
A12C29*	0160-2246	0	1	CAPACITOR-FXD 3.6PF +-.25PF 500VDC CER	28480	0160-2246
A12C29*	0160-2247	1	1	CAPACITOR-FXD 3.9PF +-.25PF 500VDC CER *FACTORY SELECTED PART	28480	0160-2247
A12C30	0160-4424	0	2	CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C31	0160-4424	0		CAPACITOR-FXD .047UF +-20% 500VDC CER	51642	400-500-X7R-473M
A12C32	0180-0428	8		CAPACITOR-FXD 68UF+-20% 6VDC TA	28480	0180-0428
A12C33	0140-0225	9	2	CAPACITOR-FXD 300PF +-1% 300VDC MICA	72136	DM15F301F0300WV1C
A12C34	0140-0225	9		CAPACITOR-FXD 300PF +-1% 300VDC MICA	72136	DM15F301F0300WV1C
A12C35*	0160-3873	1	1	CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER *FACTORY SELECTED PART	28480	0160-3873
A12C36*	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER *FACTORY SELECTED PART	28480	0160-3874
A12CR1	1902-3082	9	1	DIODE-ZNR 4.64V 5% DI-7 PD=.4W TC=-.023%	28480	1902-3082
A12CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR3	1901-0376	6	5	DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A12CR4	1901-0040	1		DIODE-SWAITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR5	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A12CR6	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A12CR7	1902-0126	6	2	DIODE-ZNR 2.61V 5% DO-7 PD=.4W TC=.072%	28480	1902-0126
A12CR8	1901-0376	6		DIODE-HEN PRP 35V 50MA DO-7	28480	1901-0376
A12CR9	1902-0126	6		DIODE-ZNR 2.6V 5% DO-7 PD=.4W TC=-.072%	28480	1902-0126
A12CR10	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-7	28480	1901-0376
A12CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NA DO-35	28480	1901-0040
A12CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR16	1901-0040	1		DIODE-SWTCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12CR17	1901-0040	1		DIODE-SETCHING 30V 50MA 2NS DO-35	28480	1901-0040
A12J1	1200-0548	8		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0548
A12K1	0490-0642	5	1	RELAY-RED 2C 50MA 28VDC 5VDC-COIL 3VA	28480	0490-0642
A12K2	0490-1175	1	7	RELAY-REED SPST NO 5VDC COIL	28480	0490-1175
A12K3	0490-1183	1	3	RELAY-REED SPST NO 5VDC COIL	28480	0490-1183
A12K4	0490-1175	1		SAME AS K2	28480	0490-1175
A12K5	0490-1183	1		SAME AS K3	28480	0490-1183
A12K6	0490-1175	1		SAME AS K2	28480	0490-1175
A12K7	0490-1175	1		SAME AS K2	28480	0490-1175
A12K8	0490-1175	1		SAME AS K2	28480	0490-1175
A12K9	0490-1175	1		SAME AS K2	28480	0490-1175
A12K10	0490-1175	1		SAME AS K2	28480	0490-1175
A12K11	0490-1183	1		SAME AS K3	28480	0490-1183
A12L1	9100-2288	3	2	COIL-MLD 1MH 10% Q=30 .0950X.25LG-NOM	28480	9100-2288
A12L2	9100-2288	3		COIL-MLD 1MH 10% Q=30 .095DX.25LG-NOM	28480	9100-2288
A12L3	9140-0178	0	2	COIL-MLD 12UH 12UH 10% Q=65 .155DX.375LG-NOM	28480	9140-0178
A12L4	9140-0178	0		COIL-MLD 12UH 105 Q=65 .155DX.375LG-NOM	28480	9140-0178
A12Q1	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A12Q3	1855-0213	1	2	TRANSISTOR-JFET DUAL 2N5912 N-CHAN	17856	2N5912
A12Q4	1855-0213	1		TRANSISTOR-JFET DUAL 2N5912 N-CHAN	17856	2N5912
A12R1	0698-5426	3	2	RESISTOR 10K 10% .125W CC TC=-350/+857	01121	BB1031
A12R2	0698-5426	3		RESISTOR 10K 10% .125W CC TC=-350/+857	01121	BB1031
A12R3	1810-0080	6		NETWORK-RES 8-PIN-SIP .125-PIN SPCG	28480	1810-0080
A12R4	0683-3925	2	2	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A12R5	0698-5999	5	2	RESISTOR 4.7K 5% .125W CC TC=-350/+857	01121	BB4725

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A12R6	0683-3925 2		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A12R7	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A12R8	0698-5999 5		RESISTOR 4.7K 5% .125W CC TC=-350/+857	01121	BB4725
A12R9	0683-8215 3		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R10	0683-8215 3		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R11	0675-1021 8	2	RESISTOR 1K 10% .125W CC TC=-330/+800	01121	BB1021
A12R12	0683-1025 9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A12R13	0675-1021 8		RESISTOR 1K 10% .125W CC TC=-330/+800	01121	BB1021
A12R16	0683-5115 6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R17	0683-5115 6		REISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R18	0683-2215 1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A12R19	0683-2215 1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A12R20	0683-1005 5	3	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A12R21	0683-1005 5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A12R22	0683-3315 4		RESISTOR 330 5% FC TC=-400/+600	01121	CB3315
A12R23	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R24	0683-3315 4		RESISTOR 330 5% .25W FC T=-400/+600	01121	CB3315
A12R25	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A12R26	2100-2632 4	2	RESISTOR-TRMR 100 10% C SIDE-ADJ 1=TRN	30983	ET50X101
A12R27	0698-7229 8	2	RESISTOR 511 1% .05W F CT=0+-100	24546	C3-1/8-T0-511R-G
A12R28	2100-2632 4		RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	30983	ET50X101
A12R29	0698-5996 2	2	RESISTOR 560 5% .125W CC TC=-330/+800	01121	BB5615
A12R30	0698-5996 2		RESISTOR 560 5% .125W CC TC=-330/+800	01121	BB5615
A12R31	0698-7229 8		RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-T0-511R-G
A12R32	0698-7230 1	2	RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-G
A12R33	0683-5115 6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R34	0698-6283 2		RESISTOR 10 5% .125W CC TC=-120/+400	01121	BB1005
A12R35	0698-7230 1		RESISTOR 562 1% .05W F TC=0+-100	24546	C3-1/8-T0-562R-G
A12R36	0698-6283 2		RESISTOR 10 5% .125W CC TC=-120/+400	01121	BB1005
A12R37	0683-1055 5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R38	0683-1055 5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A12R39	0683-2005 7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R40	0683-5115 6		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A12R41	0683-2005 7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R42	0698-6400 5	2	RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R43	0698-6974 8	2	RESISTOR 90K .25% .125W F TC=0+-25	28480	0698-6974
A12R44	0698-6974 8		RESISTOR 90K .25% .125W F TC=0+-25	28480	0698-6974
A12R45	0698-6400 5		RESISTOR 900K 1% .25W F TC=0+-100	19701	MF52C1/4-T0-9003-F
A12R46	0757-0442 9	2	RESISTOR 10K 1% .125W F TC=-0+-100	24546	C4-1/8-T0-1002-F
A12R47	0757-0442 9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A12R48	0757-0931 1	2	REISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A12R49	0757-0900 4	2	RESISTOR 100 2% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A12R50	0757-0931 1		RESISTOR 2K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2001-G
A12R51	0757-0900 4		RESISTOR 100 2% .125W F TC=0+-100	24546	C4-1/8-T0-101-G
A12R52					
A12R52	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A12R53	0683-4725 2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A12R54	0683-1015 7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R55	0683-1015 7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R56	2100-2633 5		RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	30983	ET50X102
A12R57	2100-2633 5		RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	30983	ET50X102
A12U1	1820-0577 7	2	IC INV TTL HEX 1-INP	01295	SN7416N
A12U2	1820-0805 4	1	IC GATE ECL EXCL-OR/NOR TPL 1-INP	04713	MC10107P
A12U3	1820-0577 7		IC INV TTL HEX 1-INP	01295	SN7416N
A12U4	1826-0426 7	1	IC COMPARATOR 16-DIP-C	34335	AM687DL
A12XU4	1200-0475 0		CONNECTOR-SGL CONT SKT .016-IN-BBC-8Z	28480	1200-0475
			A12 MISCELLANEOUS		
	1480-0116 8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	4040-0748 3		EXTRACTOR-PC BOARD BLK POLYC	28480	4040-0748
A13			NOT ASSIGNED		
A14			NOT ASSIGNED		
A15	05328-60019 8	1	HP-IS INTERFACE BOARD (SERIES 1632)	28480	05328-60019
A15C1	0180-1735 2	1	CAPACITOR-FXD .22UF+-10% 35VDC TA	5689	150D224X9035A2
A15C2	0170-0040 9	1	CAPACITOR-FXD .047UF +-10% 200VDC POLYE	56289	292P47392
A15C3	0180-0106 9	2	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A15C4	0160-0154 5	1	CAPACITOR-FXD 2200PF +-10% 200VDC POLYE	28480	0160-0154
A15C5	0160-0161 4	1	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A15C6	0170-0024	9	1	CAPACITOR-FXD .022UF +-20% 200VDC POLYE	28480	0170-0024
A15C7	0180-0229	7	2	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X901082
A15C8	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X901082
A1509	0180-1746	5	3	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X902082
A15CR1	1910-0016	0	7	DIODE-GE 60V 60MA 1US DO-7	82480	1910-0016
A15CR2	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	82480	1910-0016
A15CR3	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15CR4	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15CR5	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15CR6	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A15J6	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A15Q1	1854-0215	1	4	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A15Q2	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A15Q3	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A15Q4	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A15Q5	1853-0036	2		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A15R1	0683-3035	5	1	RESISTOR 30K 5% .25W FC TC=400/+800	01121	CB3035
A15R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC+-400/+700	01121	CB1035
A15R3	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R4	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R5	0683-3325	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A15R6	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R7	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R8	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R10	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R11	0683-1235	3	1	RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A15R12	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R13	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R14	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A15R15	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R17	0683-1535	6	1	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A15R18	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R19	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R20	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R21	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R22	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R23	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A15R24	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A15R25	0683-2725	8	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A15R26	0683-2025	1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A15R27	0683-3025	3		RESISTOR 3K 5% .25W FT TC=-400/+700	01121	CB3025
A15R28	0683-3025	3		RESISTOR 3K 5% .25W FC TC =-400/+700	01121	CB3025
A15R29	1810-0136	3	2	NETWORK-RES 10-PIN-SIP .1-PIN-SPCG	28480	1810-0136
A15R30	1810-0136	3		NETWORK-RES 10-PIN-SIP .1-PIN-SPCG	28480	1810-0136
A15R31	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A15R32	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A15R33	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A15R34	1810-0055	5		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A15R35	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1581	3101-1973	7	1	SWITCH-SL 7-1A-NS DIP-NS DIP-SLIDE-ASSY .1A	28480	3101-1973
A15U1	1820-0261	6	1	IC MV TTL MONOSTBL	01295	SN74121N
A15U2	1820-0904	4	1	IC COMPTR TIL L MAGTD 5-BIT	07263	93L24PC
A15U3	1820-0658	5	5	IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP	07263	93L12PC
A15U4	1820-0174	0	3	IC INV TTL MEX 1-INP	01295	8N7404N
A15U5	1820-0621	2	3	IC BFR TTL NAND QUAD 2-INP	01295	8N7438N
A15U6	1820-0658	5		IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP	07263	93L12PC
A15U7	1820-0099	8	1	IC CNTR TTL BIN ASYNCHRO NEG-EDGE-TRIG	01295	SN7493N
A15U8	1820-0658	5		IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP	07263	93L12PC
A15U9	1820-0174	0		IC INV TTL HEX 1-INP	01295	8N7404N
A15U10	1820-0621	2		IC BFR TTL NAND QUAD 2-INP	01295	8N7438N
A15U11	1820-0077	2	2	IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A15U12	1820-0658	5		IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP	07263	93L12PC
A15U13	1820-0627	8	1	IC DCDR TTL L BCD-TO-DEC 4-TO-10-LINE	07263	93L01PC
A15U14	1820-1057	0	2	IC CNTR TTL L BIN SYNCHRO POS-EDGE-TRIG	27014	DM86L76N
A15U15	1820-0656	3	1	IC MUXR/DATA-SEL TTL L 2-TO-1-LINE QUAD	01295	SN74L98N
A15U16	1820-0621	2		IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A15U17	1820-0054	5	3	IC GATE TTL NAND QUAD 2-INP	01295	8N7400N
A15U18	1820-1056	9	1	IC SCHMITT-TRIG TTL NAND QUAD 2-INP	01295	SN74132N
A15U19	1820-1358	4	3	IC LCH TTL L COM CLEAR 8-BIT	07263	93L34PC
A15U20	1820-0269	4	2	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER		QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A15U21	1820-0174	0		IC INV TTL HEX 1-INP	01295	SN7404N
A15U22	1818-2253	5	1		28480	1818-2253
A15U23	1820-1057	0		IC CNTR TTL L BIN SYNCHRO POS-EDGE-TRIG	27014	DM86L76N
A15U24	1820-0876	9	1	IC LCH TTL L D-TYPE 4-BIT	01295	SN74L75N
A15U25	1820-0054	5		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A15U26	1820-1358	4		IC LCH TTL L COM CLEAR 8-BIT	07263	93L34PC
A15U27	1820-0269	4		IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A15U28	1820-1166	2	2	IC FF TTL L D-TYPE COM CLEAR QUAD	27014	DM85L51N
A15U29	1820-0054	5		IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A15U30	1820-0282	1	1	IC GATE TTL EXCL-DR QUAD 2-INP	01295	SN7486N
A15U31	1820-0077	2		IC FF TTL D-TYPE POS-EDGE-TRIG CLEAR	01295	SN7474N
A15U32	1820-0658	5		IC MUXR/DATA-SEL TTL L 8-TO-1-LINE 8-INP	07263	93L12PC
A15U33	1820-1358	4		IC LCH TTL L COM CLEAR 8-BIT	07263	93L34PC
A15U34	1820-1166	2		IC FF TTL L D-TYPE COM CLEAR QUAD	27014	DM85L51N
A15W1	05328-60110	0	1	CABLE ASSEMBLY, HP-IB SINGLE	28480	05328-60110
				A15 MISCELLANEOUS		
	0380-0529	4	4	STANDOFF-HEX 1.25-IN-LG 6.32THD	00000	ORDER BY DESCRIPTION
	0380-0644	4	2	STANDOFF-METRIC SHORT STUD MOUNT: FOR	28480	0380-0644
	1200-0485	2	4	SKT-IC,14 PIN, PC MTG: RT AGL: CONT	28480	1200-0485
	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.45-IN PIN CTR	00000	ORDER BY DESCRIPTION
A16	05328-60026	7	1	DISPLAY ASSEMBLY (SERIES 1636)	28480	05328-60026
A16C1	0180-0124	1	1	CAPACITOR-FXD 200UF=75-10% 6VDC AL	56289	30D207G006DC2
A16CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO.35	28480	1901-0040
A16CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16CR4	1910-0016	0		DIODE-GE 60V 60MA 1US DO-7	28480	1910-0016
A16CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A16DS1	1990-0437	7	9	DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16D82	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS3	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS4	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS5	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS6	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS7	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS8	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS9	1990-0437	7		DISPLAY-NUM SEG 1-CHAR .43-H	28480	5082-7751
A16DS10	1990-0404	8	10	LED-VISIBLE LUM-INT-300UCD IF-50MA-MAX	28480	5082-4480
A16DS11	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA.MAX	28480	5082-4480
A16DS12	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS13	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS14	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS15	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS16	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS17	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS18	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16DS19	1990-0404	8		LED-VISIBLE LUM-INT=300UCD IF=50MA-MAX	28480	5082-4480
A16Q1	1853-0326	3	9	TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q2	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q3	1853-0326	3		TRAMSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q4	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q5	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q6	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q7	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q8	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q9	1853-0326	3		TRANSISTOR PNP SI PD=1W FT=50MHZ	28480	1853-0326
A16Q10	1854-0492	6	12	TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q11	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q12	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q13	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q14	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q15	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q16	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q17	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q18	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q19	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q20	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16Q21	1854-0492	6		TRANSISTOR NPN SI PD=350MW FT=250MHZ	28480	1854-0492
A16R1	0683-3905	8	3	RESISTOR 39 5% .25W FC TC=400/+500	01121	CB3905
A16R2	0683-3905	8		RESISTOR 39 5% .25W FC TC=-400/+500	01121	CB3905
A16R3	0683-3905	8		RESISTOR 39 5% .25W FC TC=400/+500	01121	CB3905
A16R4	1810-0213	7	1	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0213
A16R5	0683-1005	5		RESISTOR 10 5% .25W FC TC=400/+500	01121	CB1005

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A16R6	2100-3455 1	1	RESISTOR-VAR CONTROL CCP 2.5M 20% 10CW	01121	WP4G048P255RZ
A16R7	0683-2005 7		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A16R8	0683-3325 6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A16R9	0683-1025 9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A16R10	0683-1025 9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A16S1	3101-1621 2	1	SWITCH-TGL SUBMIN DPDT NS 2A 250VAC PC	28480	3101-1621
A16S2	3101-1940 8	1	SWITCH-PB DPDT MOM .02A 20VAC	28480	3101-1940
			A16 MISCELLANEOUS		
	1200-0474 9	9	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
	1251-0600 0		CONNECTOR-SGL CONT PIN 1.143MM3BSC-SZ SQ	28480	1251-0600
	1251-2582 1	1	CONNECTOR-PC EDGE 24-CONT/ROW 2-ROWS	28480	1251-2582
	5001-0156 6	1	CONTACT, PC	28480	5001-0156
	5001-0157 7	1	SPRING, PC	28480	5001-0157
	5040-6948 8	1	INSULATOR,MALE	28480	5040-6948
	5040-6949 9	1	INSULATOR, FEMALE	28480	5040-6949
	05000-20017 7	1	SPACER, LED, SINGLE	28480	05000-20017
	05328-20252 7	2	SPACER,STANDOFF	28480	05328-20252
	05328-40003 8	1	SPACER, LED, LONG	28480	05328-40003
	3130-0498 0	1	SHAFT & INDEX ASSEMBLY 45 DEG INDEX, 8	28480	3130-0498
	3130-0500 5	1	SHAFT & INDEX ASSEMBLY 36 DEG INDEX; 10	28480	3130-0500
A17			NOT ASSIGNED		
A18			NOT ASSIGNED		
A19	05328-60030 3	1	SWITCH ASSEMBLY (SERIES 1736)	28480	05328-60030
A19C1	0180-0106 9		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A19C2	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100UDC CER	28480	0160-3879
A19C3	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C4	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C5	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C6	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C7	0160-3879 7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C8	0180-1746 5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19C9	0180-1746 5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19C10	0160-3490 8	1	CAPACITOR-FXD 1UF +-20% 50VDC CER	28480	0160-3490
A19CR2	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO.35	28480	1901-0040
A19CR3	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO.35	28480	1901-0040
A19CR4	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO.35	28480	1901-0040
A19CR5	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR6	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR7	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR8	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR9	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR11	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR12	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR13	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR14	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19CR15	1901-0040 1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A19DS1	1990-0485 5	2	LED-VISIBLE LUM-INT-800UCD IF=30MA-MAX	28480	5082-4984
A19DS3	1990-0485 5		LED-VISIBLE LUM-INT-800UCD IF=30MA-MAX	28480	5082-4984
A19J1	1251-2034 8	1	CONNECTOR-PC EDGE 10-CONT/ROW 2-ROWS	28480	1251-2034
A19J2	1250-1163 0	2	CONNECTOR-RF BNC FEM PC 50-DHM	28480	1250-1163
A19J3	1251-1626 2	1	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1626
A19J4	1250-1163 0		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1163
A19R1	2100-3516 5	2	RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	01121	WRS4G056S103M
A19R2	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R5	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R7	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R8	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R10	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R11	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R13	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R14	0683-1035 1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A19R15	0683-2025 1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A19R16	0683-1035 1		RESISTOR 10LK 5% .25W FC TC=-400/+700	01121	CB1035
A19R17	0683-1525 4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R18	0683-2715 6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A19R19	0683-2715 6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A19R20	0683-1525 4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
A19R21	0683-6815 5	2	RESISTOR 680 5% FC TC=-400/+600	01121	CR6815
A19R22	0683-1525 4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A19R23	0683-3315 4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R24	0683-3315 4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A19R25	0683-1525 4		RESISTOR 1.5K .25W FC TC=-400/=700	01121	CB1525
A19R26	0683-2025 1		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A19R27	0683-6815 5		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A19R28	2100-3516 5		RESISTOR-VAR W/SW 10K 20% LIN SPST-NO	01121	WRS4G056S103M
A19S1	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19S2	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19S3	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A1984	3101-1313 9	1	SWITCH-SL DP3T-NS MINTR .5A 125VAC/DC PC	28480	3101-1313
A19S5	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19S6	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19S7	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19S8	3101-1596 0		SWITCH-SL DPDT-NS MINTR 1A 125VAC PC	28480	3101-1596
A19TP1	0360-0124 3		CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND	28480	0360-0124
A19U1	1820-1052 5		IC XLTR ECL/TTL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
			A19 MISCELLANEOUS		
	05328-40004 9	2	STANDOFF, LED, SHORT	28480	05328-40004
	05328-60121	1	KIT-SPARE PARTS CONSIST OF:	28480	05328-60121
	1990-0404	3	LED, RED MIN	28480	1990-0404
	1990-0437	3	LED, INDICATOR	28480	1990-0437
	1990-0485	1	LED, GREEN MIN	28480	1990-0485
	05328-60120	1	CABLE ASSEMBLY,OVERLOAD	28480	05328-60120
	2110-0001	6	FUSE,1A F. BLO	28480	2110-0001
	2110-0002	5	FUSE, ,A F. BLO	28480	2110-0002
	2110-0301	5	FUSE, .12A MIN. AX	28480	2110-0301

TABLE 6-1. REPLACEABLE PARTS (CONTINUED)

REFERENCE DESIGNATION	HP PART NUMBER	QTY	DESCRIPTION	MFR CODE	MFR PART NUMBER
			CHASSIS PARTS		
B1	0950-1589 7	1	FAN AND CONTROL MODULE ASSEMBLY	28480	0950-1589
C1A	0160-0676 6	2	CAPACITOR-FXD 1800PF +-10%	28480	0160-0676
C1B	0160-0676 6		CAPACITOR-FXD 1800PF/1800PF +-10%	28480	0160-0676
F1	2110-0001 8	1	FUSE 1A 250V FAST-BLO 1.25X.25 UL IEC	75915	312001
F1	2110-0002 9	1	FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC	75915	312002
	2110-0464 7	1	FUSEHOLDER-EXTR POST 20A 300V UL/IEC	75915	345002-010
	2110-0465 8	1	FUSEHOLDER CAP EXTR PST, BAYONET, 20A	28480	2110-0465
	2110-0467 0	1	NUT-HEX 1/2-28 THD 0.688 A/F	75915	903-070
Q1	0340-0765 6	5	INSULATOR-XSTR KAPTON	28480	0340-0765
Q2	0340-0765 6		INSULATOR-XSTR KAPTON	28480	0340-0765
Q7	0340-0765 6		INSULATOR-XSTR KAPTON	28480	0340-0765
Q8	0340-0765 6		INSULATOR-XSTR KAPTON	28480	0340-0765
Q11	0340-0765 6		INSULATOR-XSTR KAPTON	28480	0340-0765
S1	3101-1234 3	1	SWITCH-SL DPDT-NS STD 1.5A 250VAC	28480	3101-1234
T1	9100-3046 3	1	TRANSFORMER-PWR PRI: 100/120/220/240V	28480	9100-3046
W1	8120-1378 1	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT	27480	8120-1378
			MISCELLANEOUS PARTS		
	0380-0004 0	2	SPACER,RND .188.IN.LG .18.IN.ID	00000	ORDER BY DESCRIPTION
	1200-0547 7	6	LOCK-DUAL INLINE PKG IC FOR 14 PIN	28480	1200-0547
	1250-0083 1	3	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0083
	1390-0406 8	4	FASTENER-CATCH STRIKE PL 16 GA STL, 1.00	28480	1390-0406
	1400-0560 8	1	CLAMP/HOLDER-CMPNT/CA (MISC)3	28480	1400-0560
	2190-0016 3	1	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	4040-1214 0	1	PANEL, PLASTIC	28480	4040-1214
	7101-0470 1	1	COVER ASSEMBLY	28480	7101-0470
	7120-7018 3	1	NAME PLATE, FRONT	28480	7120-7018
	8120-0520 3	3	CABLE ASSY	28480	8120-0520
	5040-7216 5	2	WASHER, HANDLE	28480	5040-7216
	5040-7221 2	4	FOOT, REAR	28480	5040-7221
	5040-7224 5	2	HANDLE ADAPTER	28480	5040-7224
	8120-2176 9	1	CABLE ASSY	28480	8120-2176
	05328-00003 4	1	BRACKET,FRONT	28480	05328-00003
	05328-00011 4	1	SHIELD, FREQUENCY C	28480	05328-00011
	05328-00014 7	1	PLATE, COVER, ASCII	28480	05328-00014
	05328-00017 0	1	PANEL, REAR	28480	05328-00017
	05328-00019 2	1	BRACKET, FAN	28480	05328-00019
	05328-00020 5	1	HANDLE, FRONT	28480	05328-00020
	05328-00021 6	1	COVER, TOP	28480	05328-00021
	05328-00022 7	1	COVER, BOTTOM	28480	05328-00022
	05328-20212 9	1	PANEL, DISPLAY	28480	05328-20212
	05328-20217 4	1	PANEL, FRONT	28480	05328-20217
	05328-20253 8	2	THUMB SCREW	28480	05328-20253
	05328-60115 5	1	CABLE ASSEMBLY, OSCILLATOR	28480	05328-60115
	05328-60120 2	2	CABLE ASSEMBLY, OVERLOAD INDICATOR (WITH A8DS1)	28480	05328-60120
	05328-62016 9	2	BOARD ASSEMBLY, EXTENDER	28480	05328-62016
	05328-90055 4	1	MANUAL, OPERATING AND SERVICE	28480	05328-90055
	05328-90057 8	1	BOOKLET, OPERATING	28480	05328-90057
	1460-1345 5	2	TILT STAND SST	28480	1460-1345
	2950-0001 8	6	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	2950-0035 8	4	NUT-HEX-DBL-0CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
	0370-1005 2	1	KNOB-BASE-PTR 3/8 JGK .125-IN-ID	28480	0370-1005
	0370-1097 2	1	KNOB-BASE-PTR 1/2 JGK .125-IN-ID	28480	0370-1097
	0370-1107 5	2	KNOB-BASE-PTR-AND-BAR 1/2 JGK .25-IN-ID	28480	0370-1107
	1251-2357 8	1	CONNECTOR-AC PWR HP-9 MALE FLG-MTG	28480	1251-2357
	3101-0851 8	1	CAP-PUSHBUTTON BLACK; .2-IN DIA; .155-IN	28480	3101-0851
	7120-0644 1	1	LABEL, WARNING	28480	7120-0644
	7122-0097 2	1	NAMEPLATE, REAR	28480	7122-0097
	5020-8801 4	1	FRAME, FRONT, FULL	28480	5020-8801
	5020-8802 5	1	FRAME, REAR	28480	5020-8802
	5020-8831 0	2		28480	5020-8831
	5040-7201 8	4	FOOT(STANDARD)	82480	5040-7201
	5040-7202 9	1	TRIM, TOP	28480	5040-7202
	05328-00001 2	1	BRACKET, MAIN	28480	05328-00001
	05328-00002 3	3	BRACKET, CORNER	28480	05328-00002
	05328-00015 8	1	INSULATOR, P.S.	28480	05328-00015

SEE INTRODUCTION TO THIS SECTION FOR ORDERING INFORMATION

Table 6-2. Manufacturers Code list

Mfr No.	Manufacturer Name	Address	Zip Code
00000	U.S.A. Common	Any Supplier of the U.S.	
01121	Allen-Bradley Co	Milwaukee, WI	53204
01295	Texas Instr Inc Semicond Cmpnt Div	Dallas, TX	75222
0192B	RCA Corp Solid State Div	Somerville, NJ	08876
02111	Spectrol Electronics Corp	City of Ind, CA	91745
02114	Ferroxcube Corp	Saugerties, NY	12477
03508	GE Co Semiconductor Prod Dept	Syracuse, NY	13201
04713	Motorola Semiconductor Products	Phoenix, AZ	85062
07263	Fairchild Semiconductor Div	Mountain View, CA	94042
17856	Siliconix Inc	Santa Clara, CA	95054
18324	Signetics Corp	Sunnyvale, CA	94086
19701	Mepco/Electra Corp	Mineral Wells, TX	76067
24046	Transitron Electronic Corp	Wakefield, MA	01880
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
24931	Specialty Connector Co Inc	Indianapolis, IN	46227
27014	National Semiconductor Corp	Santa Clara, CA	95051
28480	Hewlett-Packard Co Corporate HQ	Palo Alto, CA	94304
30983	Mepco/Electra Corp	San Diego, CA	92121
32997	Bourns Inc Trimpot Prod Div	Riverside, CA	92507
34335	Advanced Micro Devices Inc	Sunnyvale, CA	94086
51642	Centre Engineering Inc	State College, PA	16801
52763	Stettner-Trush Inc	Cazenovia, NY	13035
56289	Sprague Electric Co	North Adams, MA	01247
72136	Electro Motive Corp Sub IEC	Willimantic, CT	06226
73138	Beckman Instruments Inc Helipot Div	Fullerton, CA	92634
75042	TRW Inc Philadelphia Div	Philadelphia, PA	19108
75915	Littelfuse Inc	Des Plaines, IL	60016
84411	TRW Capacitor Div	Ogallala, NE	69153

TABLE 6-3
PART NUMBER - NATIONAL STOCK NUMBER
CROSS REFERENCE INDEX

PART NUMBER	FSCM	NATIONAL STOCK NUMBER	REPLACEMENT PART NUMBER	REPLACEMENT FSCM	REPLACEMENT NATIONAL STOCK NUMBER	SMR CODE
DV11PS18A	73899	5910-00-983-2623				XDHZZ
0121-0059	28480	5910-00-776-4185				XDHZZ
0121-0061	28480	5910-00-983-2623				XDHZZ
0121-0180	28480	5910-00-410-2393				XDHZZ
0140-0177	28480	5910-00-917-9737				XDHZZ
0140-0202	28480	5910-00-852-2655				XDHZZ
0140-0209	28480	5910-00-920-3776				XDHZZ
0140-0214	28480	5910-00-835-3251				XDHZZ
0140-0215	28480	5910-00-023-2355				XDHZZ
0140-0221	28480	5910-00-772-6728				XDHZZ
0140-0225	28480	5910-00-078-1950				XDHZZ
0150-0096	28480	5910-00-247-7226				XDHZZ
0160-0127	28480	5910-00-809-5484				XDHZZ
0160-0128	28480	5910-00-057-3934				XDHZZ
0160-0154	28480	5910-00-879-7210				XDHZZ
0160-0161	28480	5910-00-911-9271				XDHZZ
0160-0174	28480	5910-00-234-9817				XDHZZ
0160-0314	28480	5910-00-982-8390				XDHZZ
0160-0342	28480	5910-00-776-4176				XDHZZ
0160-2055	28480	5910-00-211-1611				XDHZZ
0160-2242	28480	5910-00-957-2765				XDHZZ
0160-2244	28480	5910-00-008-4451				XDHZZ
0160-2246	28480	5910-00-430-5697				XDHZZ
0160-3043	28480	5910-00-472-5006				XDHZZ
0160-3879	28480	5910-00-477-8011				XDHZZ
0170-0024	28480	5910-00-726-6249				XDHZZ
0170-0040	28480	5910-00-829-0245				XDHZZ
0170-0055	28480	5910-00-797-9742				XDHZZ
0180-0106	28480	5910-00-127-1668				XDHZZ
0180-0119	28480	5910-00-864-8416				XDHZZ
0180-0124	28480	5190-00-962-0338				XDHZZ
0180-0229	28480	5910-00-403-2449				XDHZZ
0180-0374	28480	5910-00-931-7050				XDHZZ
0180-1701	28480	5910-00-615-7483				XDHZZ
0180-1735	28480	5910-00-430-6016				XDHZZ
0180-1746	28480	5910-00-430-6036				XDHZZ
0360-0124	28480	5940-00-993-9338				XDHZZ
0675-1021	28480	5905-00-420-7124				XDHZZ
0683-1005	28480	5905-00-960-0099				XDHZZ
0683-1015	28480	5905-00-102-5294				XDHZZ
0683-1035	28480	5905-00-998-1929				XDHZZ
0683-2015	28480	5905-00-683-2239				XDHZZ
0683-2025	28480	5905-00-686-3370				XDHZZ
0683-2055	28480	5905-00-762-8168				XDHZZ
0683-2725	28480	5905-00-882-2723				XDHZZ
0683-3015	28480	5905-00-682-4110				XDHZZ
0683-3355	28480	5905-00-402-4264				XDHZZ
0683-3905	28480	5905-00-498-6059				XDHZZ
0683-5115	28480	5905-00-801-8272				XDHZZ
0683-5125	28480	5905-00-139-1642				XDHZZ
0683-6815	28480	5905-00-727-8001				XDHZZ
0698-3111	28480	5905-00-420-7126				XDHZZ
0698-3136	28480	5905-00-891-4247				XDHZZ
0698-3152	28480	5905-00-420-7130				XDHZZ
0698-3153	28480	5905-00-974-6081				XDHZZ
0698-3156	28480	5905-00-974-6084				XDHZZ
0698-3157	28480	5905-00-433-6904				XDHZZ
0698-3160	28480	5905-00-974-6078				XDHZZ
0698-3378	28480	5905-00-856-9865				XDHZZ
0698-5103	28480	5905-00-420-7139				XDHZZ
0698-5426	28480	5905-00-139-2271				XDHZZ
0698-5996	28480	5905-00-172-4901				XDHZZ
0698-5999	28480	5905-00-444-5552				XDHZZ
0757-0199	28480	5905-00-981-7513				XDHZZ
0757-0200	28480	5905-00-891-4224				XDHZZ
0757-0279	28480	5905-00-221-8310				XDHZZ

TABLE 6-3
PART NUMBER - NATIONAL STOCK NUMBER

CROSS REFERENCE INDEX

PART NUMBER	FSCM	NATIONAL STOCK NUMBER	REPLACEMENT PART NUMBER	REPLACEMENT FSCM	REPLACEMENT NATIONAL STOCK NUMBER	SMR CODE
0757-0280	28480	5905-00-853-8190				XDHZZ
0757-0283	28480	5905-00-998-1909				XDHZZ
0757-0421	28480	5905-00-891-4219				XDHZZ
0757-0427	28480	5905-00-917-0578				XDHZZ
0757-0428	28480	5905-00-998-1794				XDHZZ
0757-0438	28480	5905-00-929-2529				XDHZZ
0757-0439	28480	5905-00-990-0303				XDHZZ
0757-0442	28480	5905-00-998-1792				XDHZZ
0757-0447	28480	5905-00-981-7530				XDHZZ
0757-0454	28480	5905-00-891-2811				XDHZZ
0757-0900	28480	5905-00-935-8470				XDHZZ
0757-0924	28480	5905-00-102-5693				XDHZZ
0757-0931	28480	5905-00-998-1825				XDHZZ
0757-0938	28480	5905-00-858-6501				XDHZZ
0757-0950	28480	5905-00-935-8481				XDHZZ
09-52-3030	27264	5935-00-238-5507				XDHZZ
1200-0063	28480	5999-00-937-4420				XDHZZ
1205-0011	28480	5999-00-789-3794				XDHZZ
1250-0083	28480	5935-00-804-5144				XDHZZ
1250-0835	28480	5935-00-068-3546				XDHZZ
1250-0870	28480	5935-00-172-1007				XDHZZ
1251-2026	28480	5935-00-446-8768				XDHZZ
1251-2034	28480	5935-00-267-2973				XDHZZ
1251-2357	28480	5935-00-233-6728				XDHZZ
1251-3246	28480	5935-00-238-5507				XDHZZ
1810-0020	28480	5905-00-173-3935				XDHZZ
1810-0041	28480	5905-00-470-7377				XDHZZ
1810-0055	28480	5905-00-548-0915				XDHZZ
1820-0054	28480	5962-00-138-5248				XDHZZ
1820-0055	28480	5962-00-493-5961				XDHZZ
1820-0068	28480	5962-00-865-4626				XDHZZ
1820-0074	28480	5962-00-451-6345				XDHZZ
1820-0077	28480	5962-00-138-5250				XDHZZ
1820-0099	28480	5962-00-102-7520				XDHZZ
1820-0174	28480	5962-00-404-2559				XDHZZ
1820-0175	28480	5962-00-229-8500				XDHZZ
1820-0196	28480	5962-00-451-3131				XDHZZ
1820-0223	28480	5962-00-614-5251				XDHZZ
1820-0301	28480	5962-00-270-1960				XDHZZ
1820-0328	28480	5962-00-009-1356				XDHZZ
1820-0537	28480	5962-01-034-9974				XDHZZ
1820-0736	28480	5962-00-513-2691				XDHZZ
1820-0802	28480	5962-00-496-2209				XDHZZ
1820-1019	28480	5962-01-022-3250				XDHZZ
1853-0016	28480	5961-00-901-4862				XDHZZ
1853-0020	28480	5961-00-904-2540				XDHZZ
1853-0036	28480	5961-00-931-0372				XDHZZ
1853-0326	28480	5961-00-471-2984				XDHZZ
1854-0071	28480	5961-00-137-4608				XDHZZ
1854-0092	28480	5961-00-943-7572				XDHZZ
1854-0215	28480	5961-00-892-8706				XDHZZ
1855-0081	82480	5961-00-350-8299				XDHZZ
1901-0040	28480	5961-00-965-5917				XDHZZ
1901-0050	28480	5961-00-914-7496				XDHZZ
1901-0376	28480	5961-00-790-7834				XDHZZ
1901-0518	28480	5961-00-430-6819				XDHZZ
1901-0535	28480	5961-00-451-8685				XDHZZ
1901-0638	28480	5961-00-471-2987				XDHZZ
1902-0031	28480	5961-00-718-7329				XDHZZ
1902-0074	28480	5961-00-766-1459				XDHZZ
1902-0126	28480	5961-00-780-8330				XDHZZ
1902-0579	28480	5961-00-452-0438				XDHZZ
1902-0774	28480	5961-00-057-7873				XDHZZ
1902-3036	28480	5961-00-350-2205				XDHZZ
1902-3082	28480	5961-00-448-9737				XDHZZ
1902-3224	28480	5961-00-195-3526				XDHZZ
1910-0016	28480	5961-00-954-9182				XDHZZ

TABLE 6-3
PART NUMBER - NATIONAL STOCK NUMBER
CROSS REFERENCE INDEX

PART NUMBER	FSCM	NATIONAL STOCK NUMBER	REPLACEMENT PART NUMBER	REPLACEMENT FSCM	REPLACEMENT NATIONAL STOCK NUMBER	SMR CODE
2100-1738	28480	5905-00-256-8993				KDHZZ
2100-2522	28480	5905-00-476-5797				KDHZZ
2100-2632	28480	5905-00-476-5718				KDHZZ
2100-2633	28480	5905-00-476-5796				KDHZZ
2110-0269	28480	5999-00-333-9620				KDHZZ
2950-0001	28480	5310-00-450-3324				KDHZZ
2950-0035	28480	5310-00-454-1335				KDHZZ
3101-1234	28480	5930-00-406-8746				KDHZZ
4040-0747	28480	5999-00-230-8833				KDHZZ
4040-0748	2848C	5999-00-230-8834				KDHZZ
4040-0752	28480	5999-00-230-8832				KDHZZ
8120-1378	28480	6150-00-008-5075				KDHZZ
8159-0005	28480	6625-01-014-3446				KDHZZ
9100-2288	28480	5950-01-013-7377				KDHZZ
9140-0096	28480	5950-00-138-1381				KDHZZ
9140-0131	28480	5905-00-919-5713				KDHZZ
9140-0137	28480	5950-00-984-3433				KDHZZ
9140-0178	28480	5950-00-199-7652				KDHZZ

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments for which the content does not apply directly. This manual applies directly to instruments having serial prefix 1808A. Refer to Section I for additional important information about serial number coverage.

7-3. MANUAL CHANGES SHEET

7-4. Instruments having serial prefixes higher than 1808A are covered with a "Manual Changes" sheet, following.

HEWLETT hp PACKARD **MANUAL CHANGES**

MANUAL DESCRIPTION

INSTRUMENT: 5328A/H42 Frequency Counter Operating and Service Manual
SERIAL PREFIX: 1808A

DATE PRINTED: JUNE 1978
HP PART NO: 05328-90055
MICROFICHE NO: 05328-90056

CHANGE DATE July 7, 1978

(This change supersedes all earlier dated changes)

- Make all changes listed as ERRATA.
- Check the following table for your instrument's serial prefix or serial number and make listed change(s) to manual

IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER	MAKE THE FOLLOWING CHANGES TO YOUR MANUAL	IF YOUR INSTRUMENT HAS SERIAL PREFIX OR SERIAL NUMBER	MAKE THE FOLLOWING CHANGES TO YOUR MANUAL
➤ 1828A	1		

► NEW OR REVISED ITEM

➤ EFIRATA

➤ Page 6-16, Table 6-1, A12 (05328-60031) Replaceable Parts:
Add (SERIES 1636) to the Description of A12.

➤ Page 8-33, Figure 8-20, A12 Component Locator:
Change "C4" to C3 and "C3" to C4. The "C3" and "C4" component locators are transposed in the illustration.

► Page 1-2, Paragraph 1-17:
Add the following sentence: The 05328-60121 Spare Parts Kit is described a the end of Table 6-1.

►Page Page 1-2, Table 1-1, Equipment Supplied:
Add KIT-SPARE PARTS HP PART NUMBER 05328-60121.

►Page Page 1-2, Paragraph 1-19:
Change "5328AF/096" to read 5328 A/H42.

➤ Page 6-12, Table 6-1, A8 (05328-60032) Replaceable Parts:
Change A8R40* to HP Part No. 0698-4132 6; RESISTOR 62 5% .125W CC TC=-270/+540; 01121; BB6205.

Change A8R67 to A8R67*; 0698-4132 6; RESISTOR 62 5% .125W CC TC=-270/+540; 01121; BB6205; "FACTORY SELECTED PART.

►Page Page 8-27, Figure 8-14, A8 (05328-60032) Schematic Diagram:
Change A8R40 and R67 to 62 ohms.

►Page Page 8-21, Figure 8-10, A3/A3A1 Schematic Diagram and Component Locator:
Change reference designator for capacitor connected to U4A pin 4 in A3 schematic diagram from C22 to C14.

Change reference designator for diode located below J2 and R16 in A3 component locator from CR4 to CR3.

► CHANGE 1 (1828A)

► Pages 6-7 and 6-8, Table 6-1, A2 (05328-60035) Replaceable Parts:
Change A2 series number from 1808 to 1828.

Change A2R34 and R35 from 0811-1340 (1Ω) to 0812-0021; RESISTOR 0.47Ω 5% 3W WW TC=0 ± 90; 91637; CW2B1-3-T2-47/100-J.

► Page 8-19, Figure 8-9, A2 (05328-60035) schematic Diagram:
Change “SERIES 1808” at top of diagram to SERIES 1828.

Change A2R34 and R35 from 1.0 to 0.47 ohms.

► Page 6-24, Table 2, Manufacturers Code List:
Add 91637 DALE ELECTRONICS INC. COLUMBUS, NE 68601

► Pages 6-16 and 6-17, Table 6-1, A12 (05328-60031) Replaceable Parts:
Change A12 series number from 1636 to 1828.

Change A12CR7 and CR9 from 1902-0126 (2.61V) to 1902-3048; DIODE-ZNR 3.48V 5% DO-7 PD= .4W TC= -.058%; 28480; 1902-3048.

► Page Page 8-33, Figure 8-20, A12 (05328-60031) Schematic Diagram:
Change A12 series number from 1636 to 1828.
Change voltage adjacent to A12CR7 and CR9 from 2.61 to 3.48V

SECTION VIII
SCHEMATIC DIAGRAMS

8-1. INTRODUCTION

8-2. This section contains schematic diagrams and part locators. The part locators shown the location by reference designator.

8-3. SCHEMATIC DIAGRAM SYMBOLS AND REFERENCE DESIGNATORS

8-4. Figure 8-1 shows the symbols used on the schematic diagrams. At the bottom of Figure 8-1, the system for reference designators, assemblies, and subassemblies are shown.

8-5. Reference Designations

8-6. Assemblies such as printed-circuit boards are assigned numbers in sequence, A1, A2, etc. As shown in Figure 8-1, subassemblies within an assembly are given a subordinate A number. For example, rectifier subassembly A1 has the complete designator of A25A1. For individual components, the complete designator is determined by adding the assembly number and sub-assembly number if any. For example, CR1 on the rectifier assembly is designated A25A1CR1.

8-7. SIGNAL MNEMONICS

8-8. Table 8-1 contains a list of the mnemonics used to identify signals on the schematic diagrams.

8-9. IDENTIFICATION MARKINGS ON PRINTED-CIRCUIT BOARDS

8-10. HP printed-circuit boards (see Figure 8-1) have four identification numbers: an assembly part number, a series number, a revision letter, and a production code.

8-11. The assembly part number has 10 digits (such as 05328-60018) and is the primary identification. All assemblies with the same part number are interchangeable. When a production change is made on an assembly that makes it incompatible with previous assemblies, a change in part number is required. The series number (such as 1704A) is used to document minor electrical changes. As changes are made, the series number is incremented. When replacement boards are ordered, you may receive a replacement with a different series number. If there is a difference between the series number marked on the board and the schematic in this manual, a minor electrical difference exists. If the number on the printed-circuit board is lower than that on the schematic, refer to Section VII for backdating information. If it is higher, refer to the loose leaf manual change sheets for this manual. If the manual change sheets are missing, contact your local Hewlett-Packard Sales and Service Office. See the listing on the back cover of this manual.

8-12. Revision letters (A, B, etc.) denote changes in printed-circuit layout. For example, if a capacitor type is changed (electrical value may remain the same) and requires different spacing for its leads, the printed-circuit board layout is changed and the revision letter is incremented to the next letter. When a revision letter changes, the series number is also usually changed. The production code is the four-digit seven-segment number used for production purposes.

8-13. Symbols are used on PC boards to aid in identifying pin numbers, diode elements, etc., as follows:

Δ OR □

IDENTIFIES:

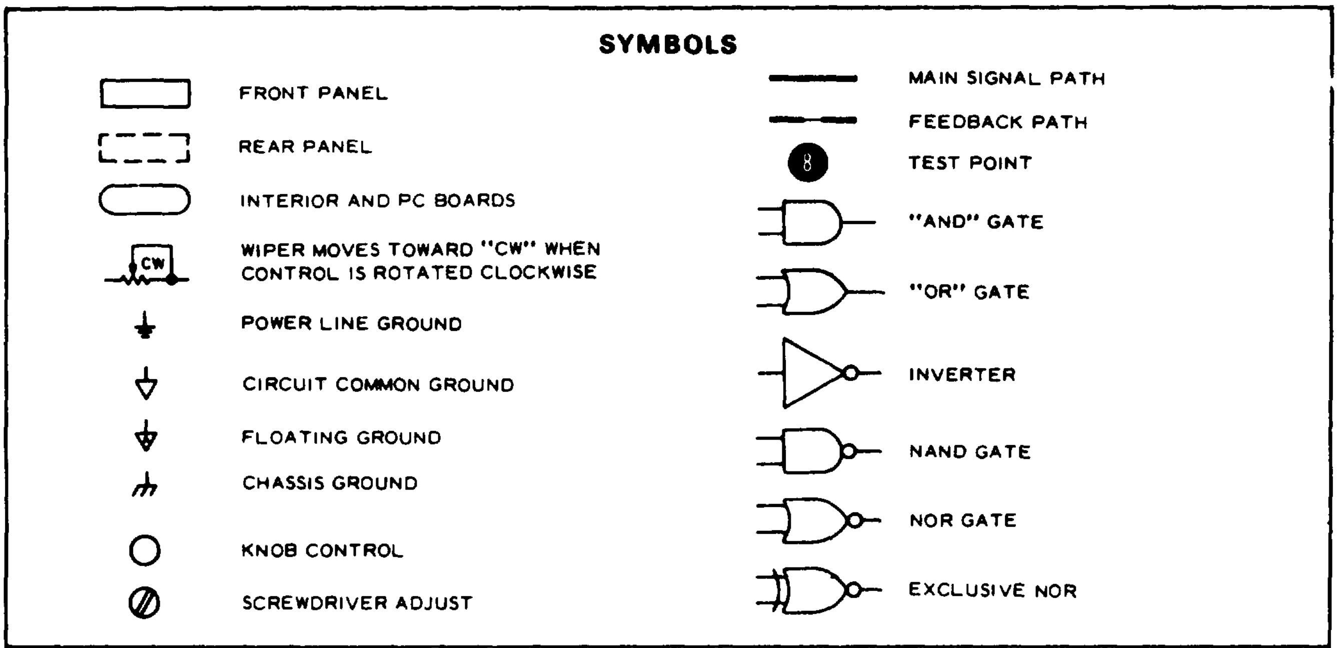
Pin 1 of dip and flat-pack IC's.
Tab of TO CASES.
+ side of electrolytic capacitors.
Pin 1 of resistor packs.
Cathode of diodes.
Section I of dip switches.

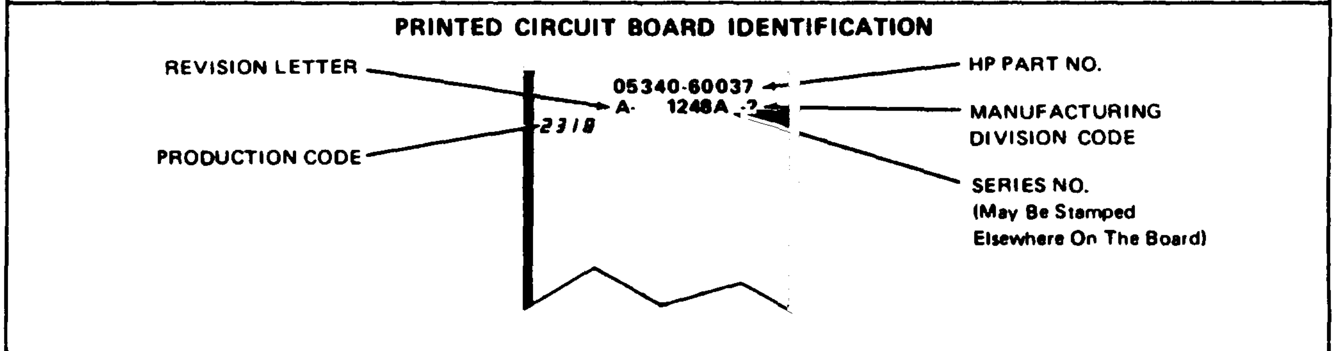
8-14. ASSEMBLY LOCATIONS AND COMPONENT LOCATORS

6-15. Figures in this section show the front, rear, and top views of the 5328A. The front and rear views shows reference designators of the front and rear panel controls, connectors, and indicators. The top view shows asssembly locations. Component locators for each printed-circuit assembly are located next to the schematics.

8-16. FACTORY SELECTED COMPONENTS

8-17. Factory sleeted parts are identified by an asterisk on the schematic and in the parts list. The nominal value is shown on the schematics and is listed in the table of replaceable parts. A table-format summary on the schematic indexes factory selected parts by reference designator, describes what they are selected for and the range of normal values.





REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION. JACKS ARE THE STATIONARY CONNECTORS AND PLUGS ARE THE MORE MOVEABLE OF TWO CONNECTORS.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3

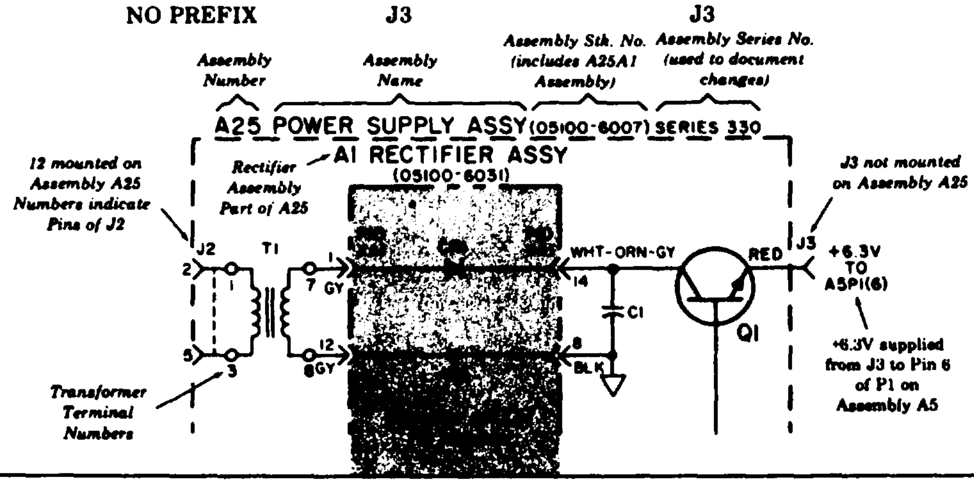


Figure 8-1. Schematic Diagram Notes

Table 8-1. Signal Mnemonics

MNEMONIC	DESCRIPTION
A $\overline{A}$	Output of Time Interval Unit, A channel. ECL levels.
R (AØ) R (A1)	Non-latched ROM bits that drive Arming Multiplexer select lines on Function Selector. TTL levels.
B B	Output of Time Interval Unit, B channel. ECL levels.
C C	Output of C module, the carry input for the FS decade. ECL levels.
C ARM	Active high TTL line used for module C arming measurement.
CLK	Clock. Digit address clock to display. TTL levels.
Data A Data B Data C Data D	TTL 4-bit BCD code. Data going to display and HP-IB.
Digit A Digit B Digit C Digit D	TTL 4-bit digit address code. Controls interchange of data.
DVM	Frequency line counted by Function Selector to give display reading. ECL level.
F Code A (FA) F Code B (FB) F Code C (FC) F Code D (FD)	Function code from function switch. TTL levels.
FS	Function Selector.
GOSC $\overline{GOSC}$	Gated oscillator. ECL levels.
HDS	TTL level high disables synchronizers.
HDSA	Used by Option 011 HP-IB Interface to strobe bus data in remote listener.
HLS	TTL level line used to strobe latches.
RL (HOPN)	Latched ROM line which locks open Function Selector main gate.
HPL	Same as LDP.
HRD	High resets decades. TTL active high.
HRS	High strobes 4K ROM, TTL active high.
HRTB	High resets time base. TTL active high. Also resets Function Selector.
R (HTBA)	Non-latched ROM bit which enables the TTL level Channel A signal from the Function Selector to be counted by the Time Base.

Table 8-1. Signal Mnemonics (Continued)

MNEMONIC	DESCRIPTION
RL (HTBB)	Latched ROM bit which enables the TTL level Channel B signal from the Function Selector to be counted by the Time Base.
R (HTBO)	Non-latched ROM bit which enables the time base to count the oscillator output.
RL (IA) RL (IB) RL (IC)	TTL level latched ROM bits that drive High Speed Multiplexer select lines on Function Selector.
L ANN	Low annunciators. TTL active low turns RHS annunciators on. Must be timed with digit address code to display selected annunciators.
LDDCA	Low disable Decade Counting Assembly (DCA). TTL active low disables DCA so that all DCA outputs are high.
LDI	Low disable indicators. TTL active low blanks RHS annunciators and all decimal points.
LDDIS	Low disable display. TTL active low blanks display except LHS annunciators.
LDP	Low decimal point. TTL active low turns decimal points on. Must be timed with digit address code to display selected decimal points.
LDSW	Low disable switches. The active low disables the FUNCTION RESOLUTION and RESET switches. Allows module control.
LEXT	Low external. TTL active low disables function and resolution switches for external control and lights RM annunciator.
LINH	Low inhibit. TTL active low inhibits starting new measurement.
LMG	Low main gate. TTL active low indicates main gate open.
RL (LMGF)	Latched ROM bit to Function Selector which selects the main gate F/F on the Function Selector to establish the gate time.
LMRES	Low when reset signal comes from display. Provides power-up type reset.
LRES	Low reset. TTL active low resets when FUNCTION, RESOLUTION, or RESET switch settings are changed. Also resets when DVM switches are changed. Provides power-up type of reset.
R (LST)	Non-latched ROM line which is high in stop totalize and low in start.
RL (LTOT)	Low totalize. Latched ROM bit low in totalize mode. TTL level.
LTR	Low transfer. TTL active low used in DCA.
MG M G	Main gate. Accurate signal to drive remote gate such as channel C. ECL levels.
OSC	10 MHz oscillator. TTL level.

Table 8-1. Signal Mnemonics (Continued)

MNEMONIC	DESCRIPTION
OSC OSC	100 MHz oscillator. ECL levels.
OVFL	Overflow. TTL active low indicates display overflow.
RG	ROM bit. Used to recognize period and institute hysteresis compensation. TTL level.
RL1 (HEC)	Latched ROM bit. TTL level enables channel C to strobe its digit onto the bus.
RL2 (BIL)	Latched ROM bit. High for time interval average. TTL level.
RL3 (HDVM)	Latched ROM bit. Enables DVM to strobe a minus sign on the display or blank characters. TTL level.
RL4 (LTIF)	Latched ROM bit. TTL level low in time interval or period measurement.
RL5 (TIO)	Latched ROM bit. TTL level used to recognize period average.
RL6 (HC)	Latched ROM bit which turns hysteresis compensation on and has a time interval as opposed to a period measurement made by the Time Interval unit, TTL level.
SRT	The charge node line that controls the sample rate speed.
RL (TBA) RL (TBB) RL (TBC)	Latched ROM bits that drive Time Base select code inputs.
TBI TBO	TTL signal that drives Time Base. Time Base scaled output. TTL levels.
TBS Code A (TBSA) TBS Code B (TBSB) TBS Code C (TBSC)	Time Base code input to ROM controlled by the Time Base switch. TTL levels.
TI TI	Time interval. Output of Time Interval module used in time interval measurements, ECL levels.

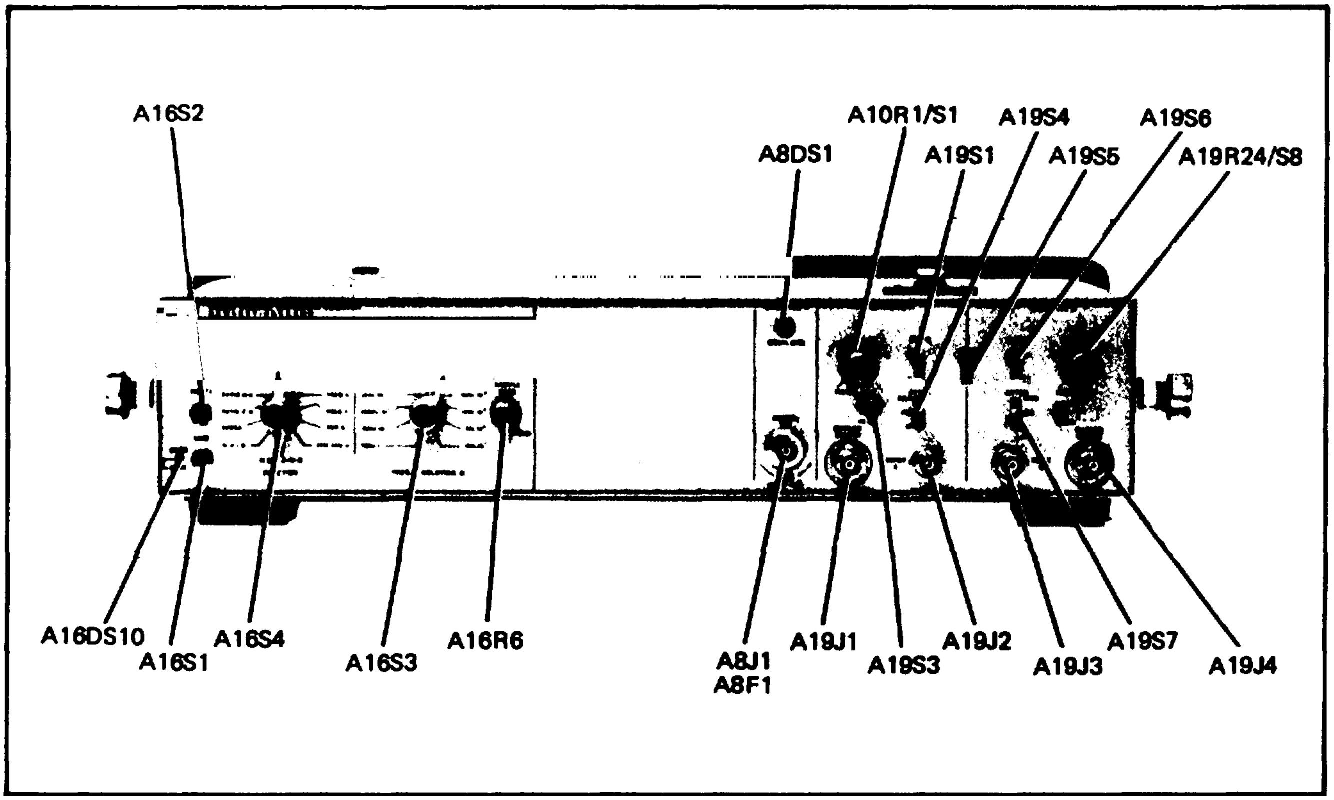


Figure 8-2. 5328A Front View

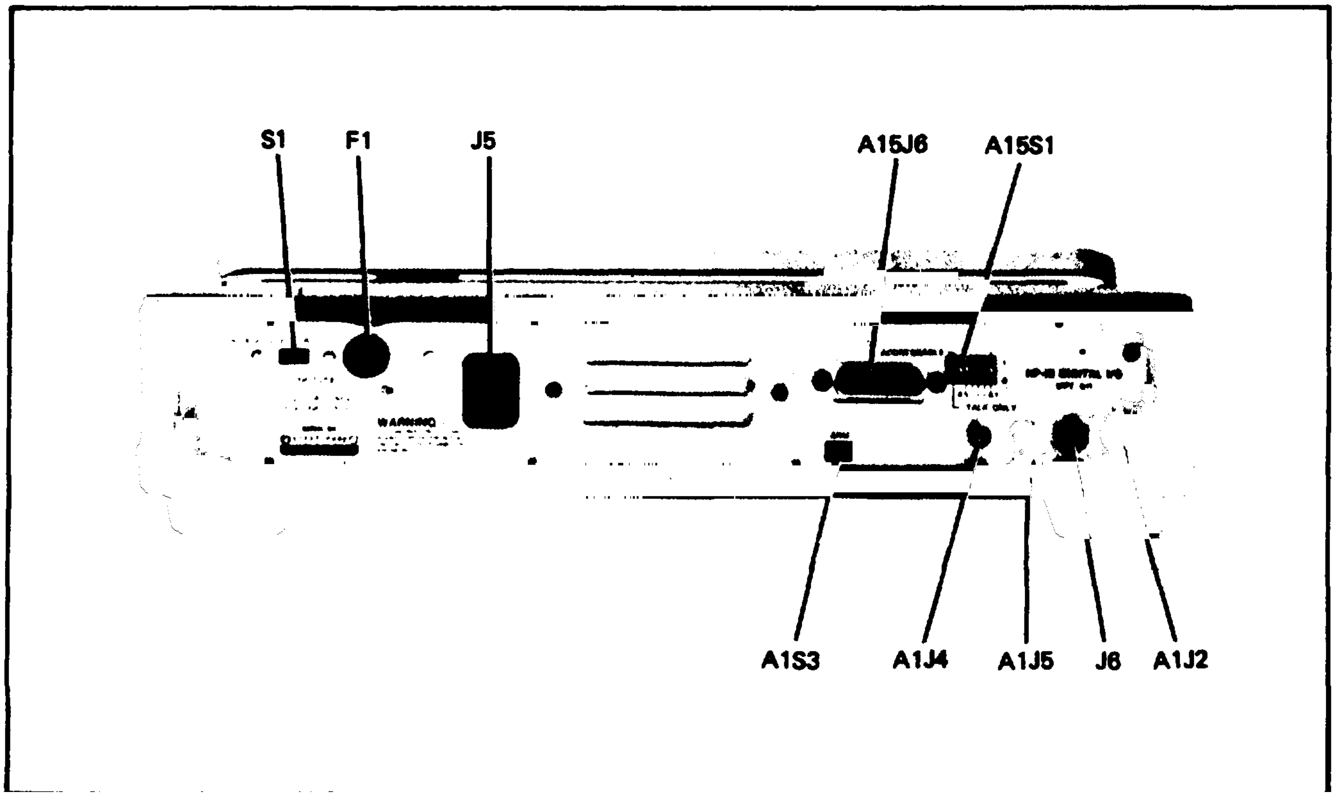


Figure 8-3 5328A Rear View

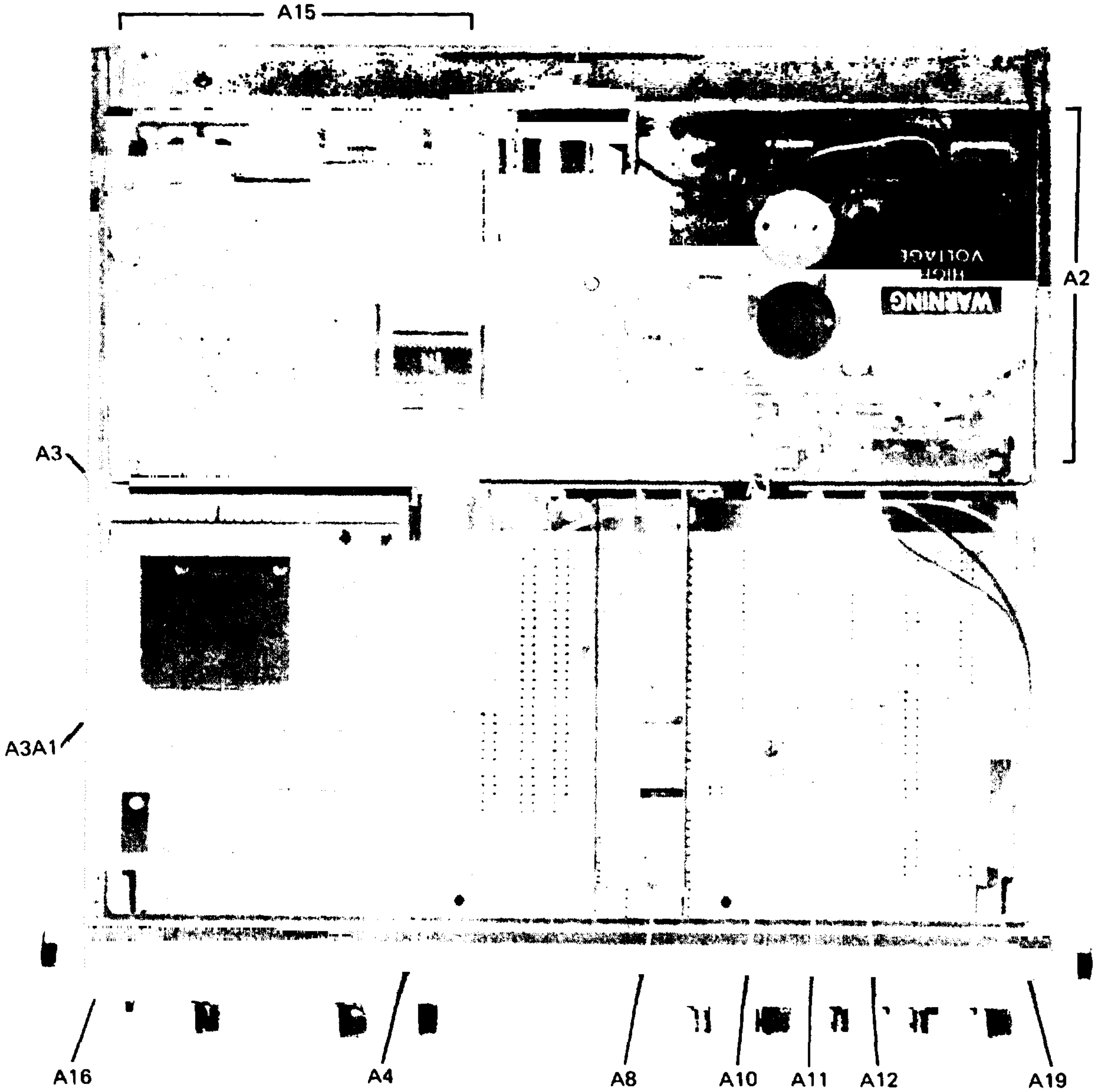


Figure 8-4. 5328A Top View

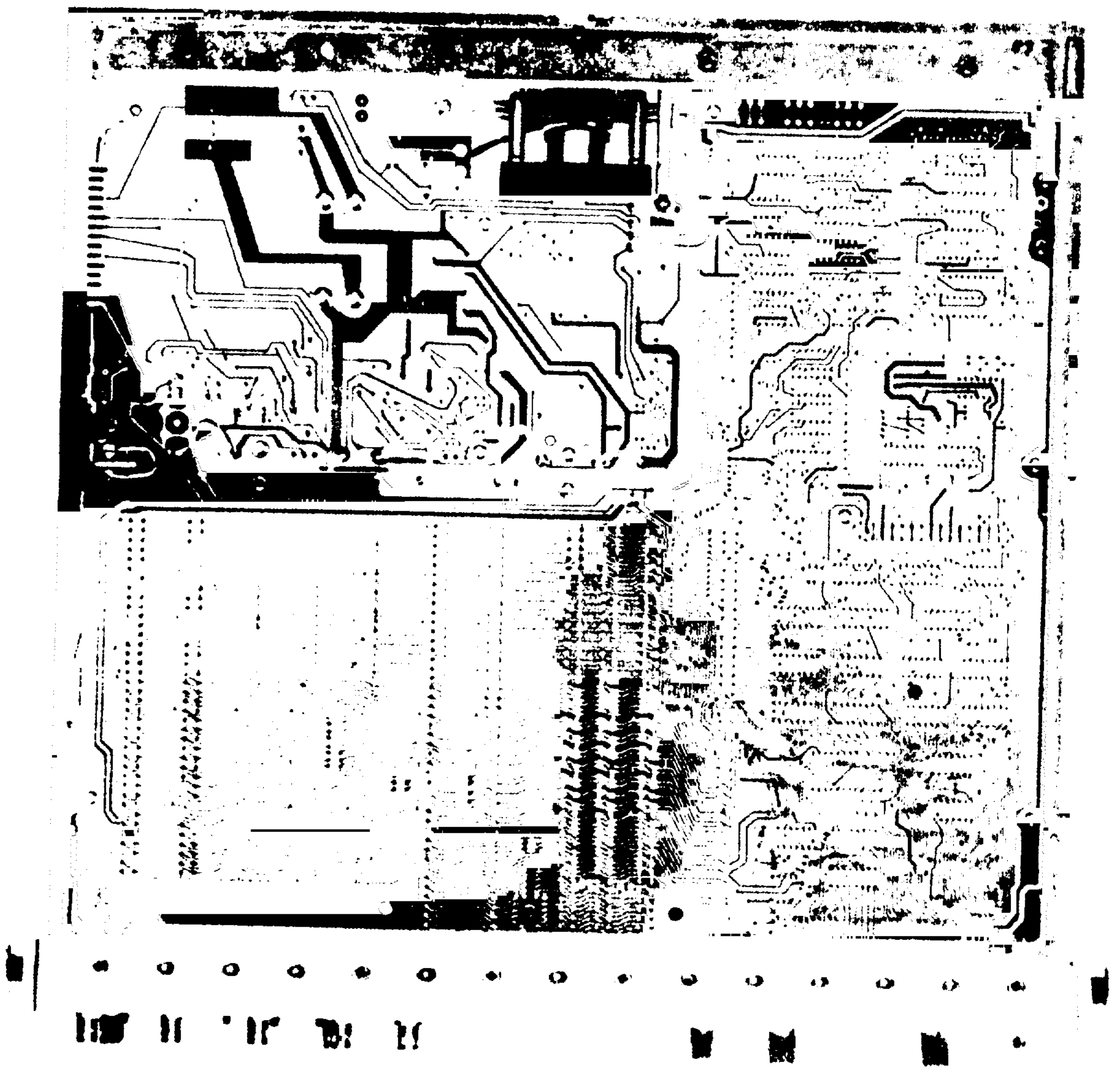
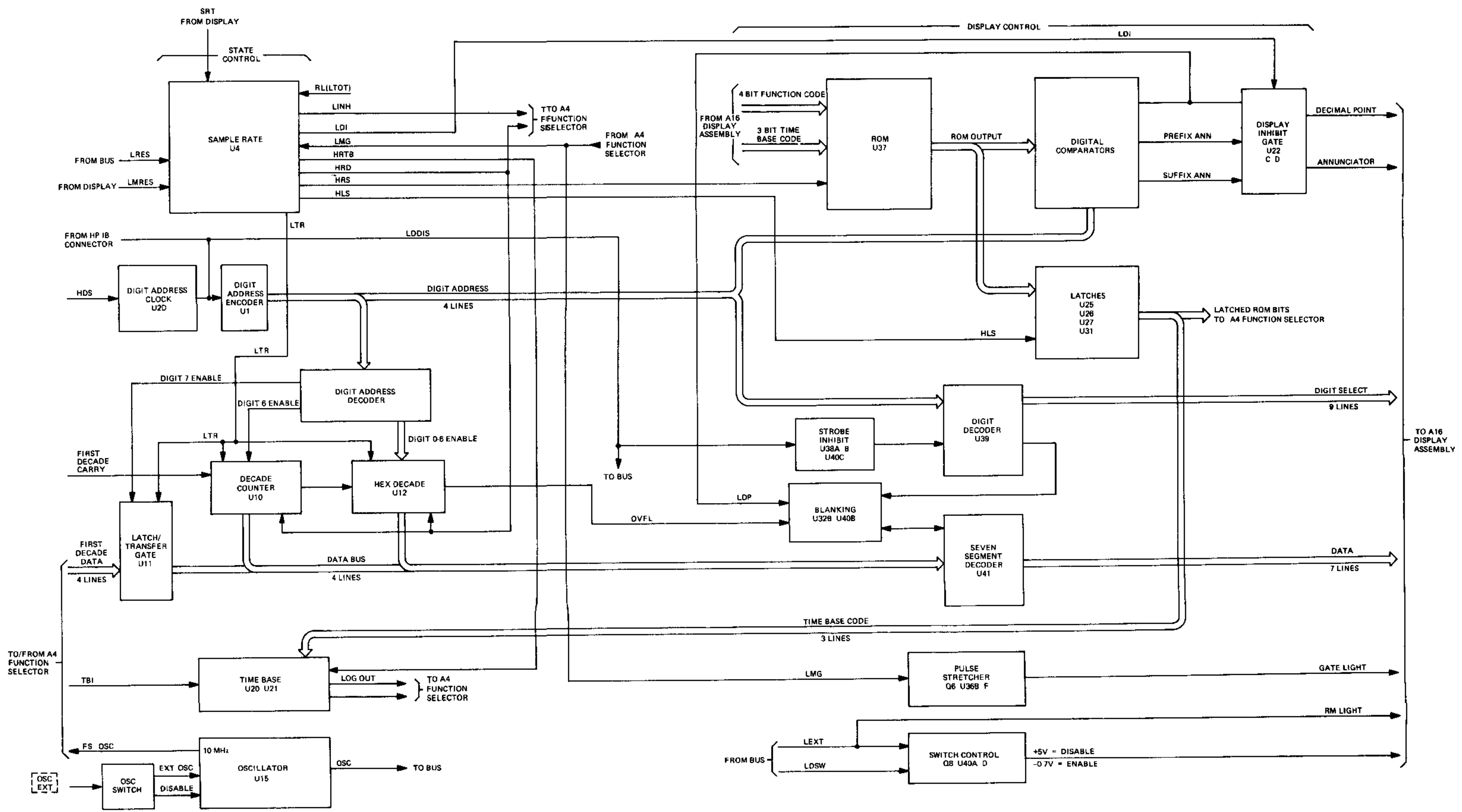
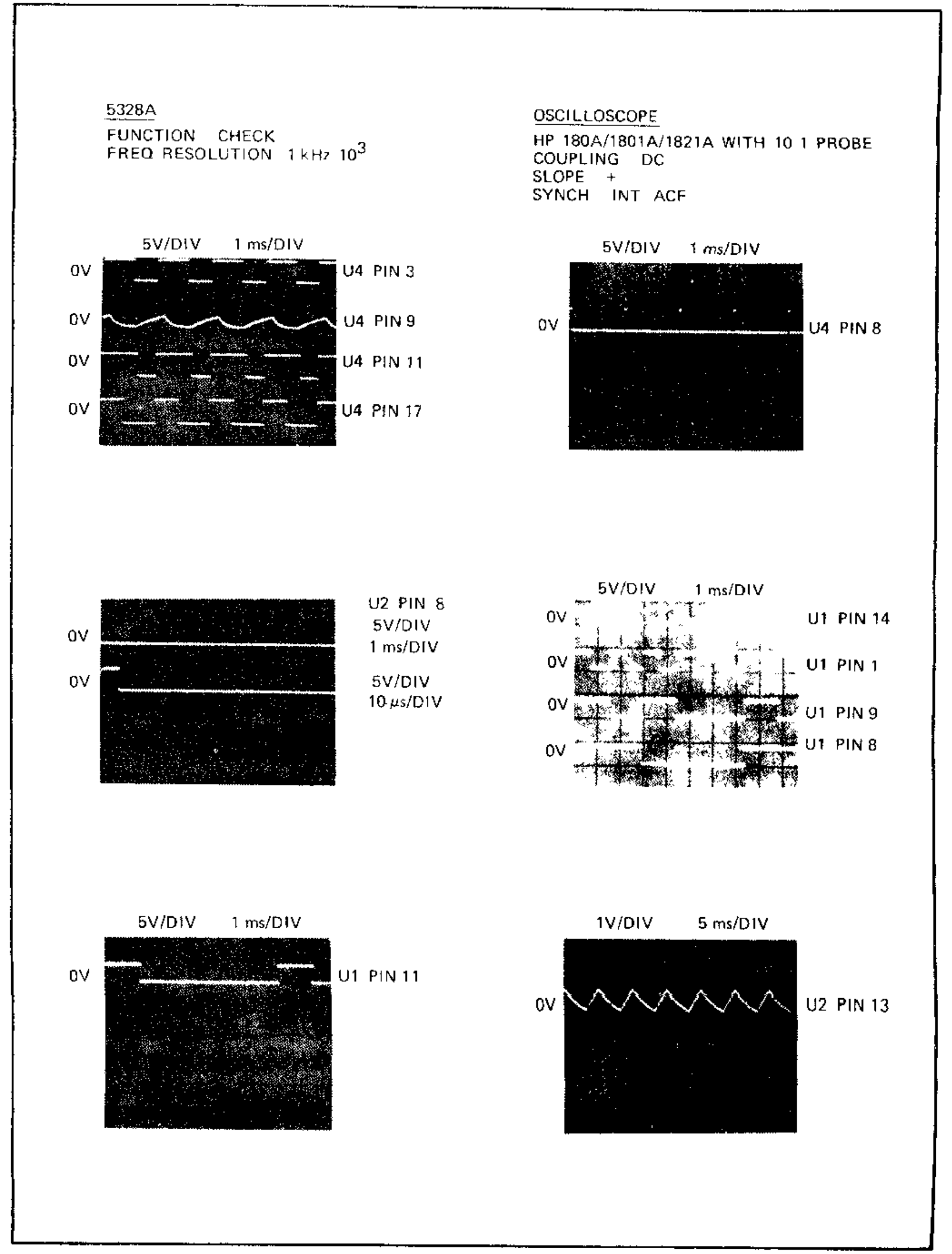


Figure 8-5. 5328A Bottom View

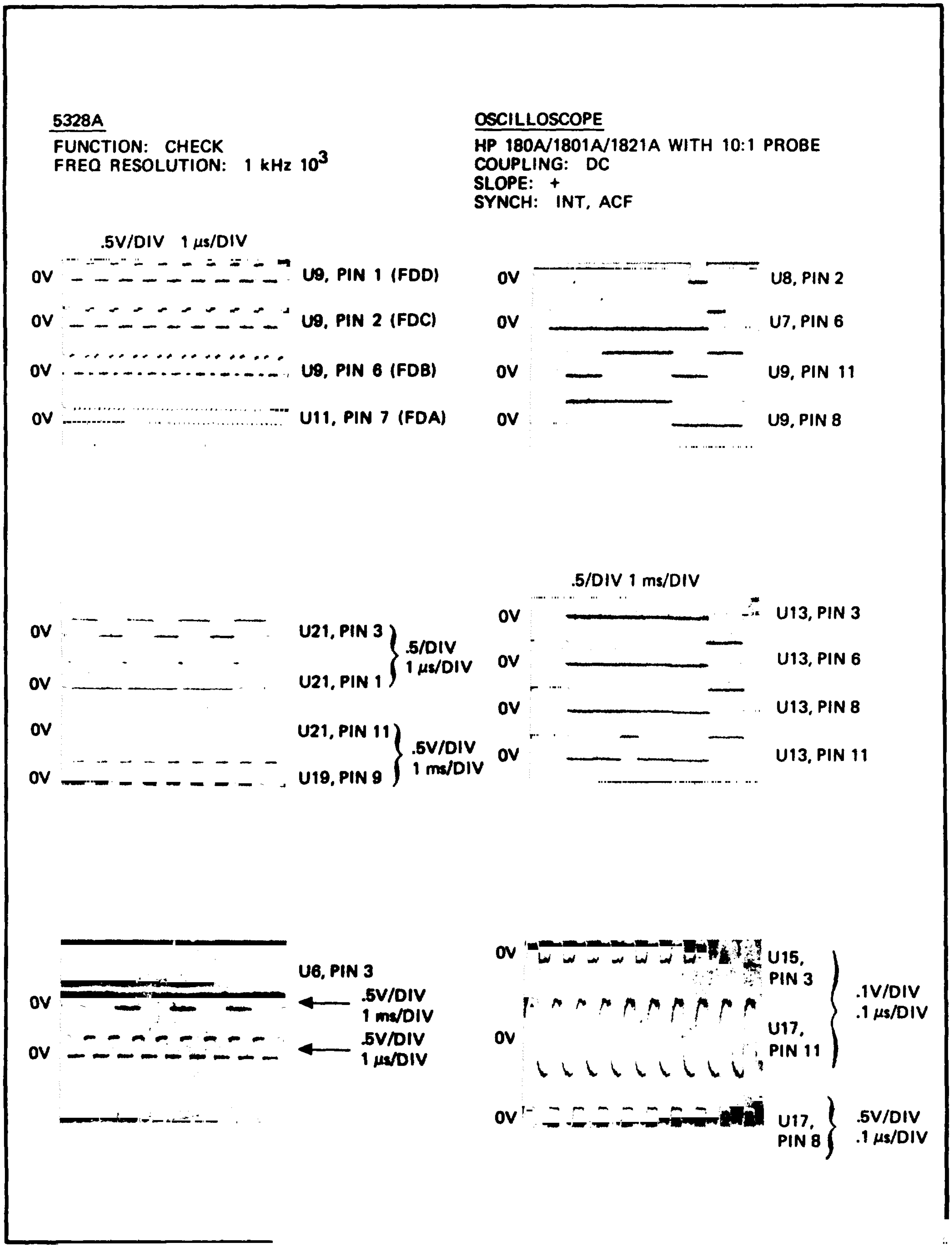


NOTE REFER TO TABLE 6-1 FOR DESCRIPTION OF SIGNAL MNEMONICS

Figure 8-6. A1 Motherboard



P/O Figure 8-7. A1 Mother board Assembly



P/O Figure 8-7. A1 Motherboard Assembly

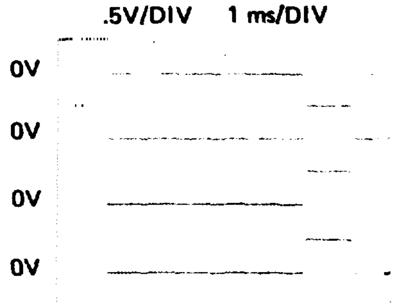
5328A

FUNCTION: CHECK
FREQ RESOLUTION: 1 kHz 10^3

OSCILLOSCOPE

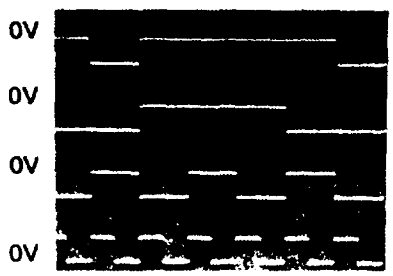
HP 180A/1801A/1802A WITH 10:1 PROBE
COUPLING: DC
SLOPE: +
SYNCH: INT, ACF

.5V/DIV 1 ms/DIV



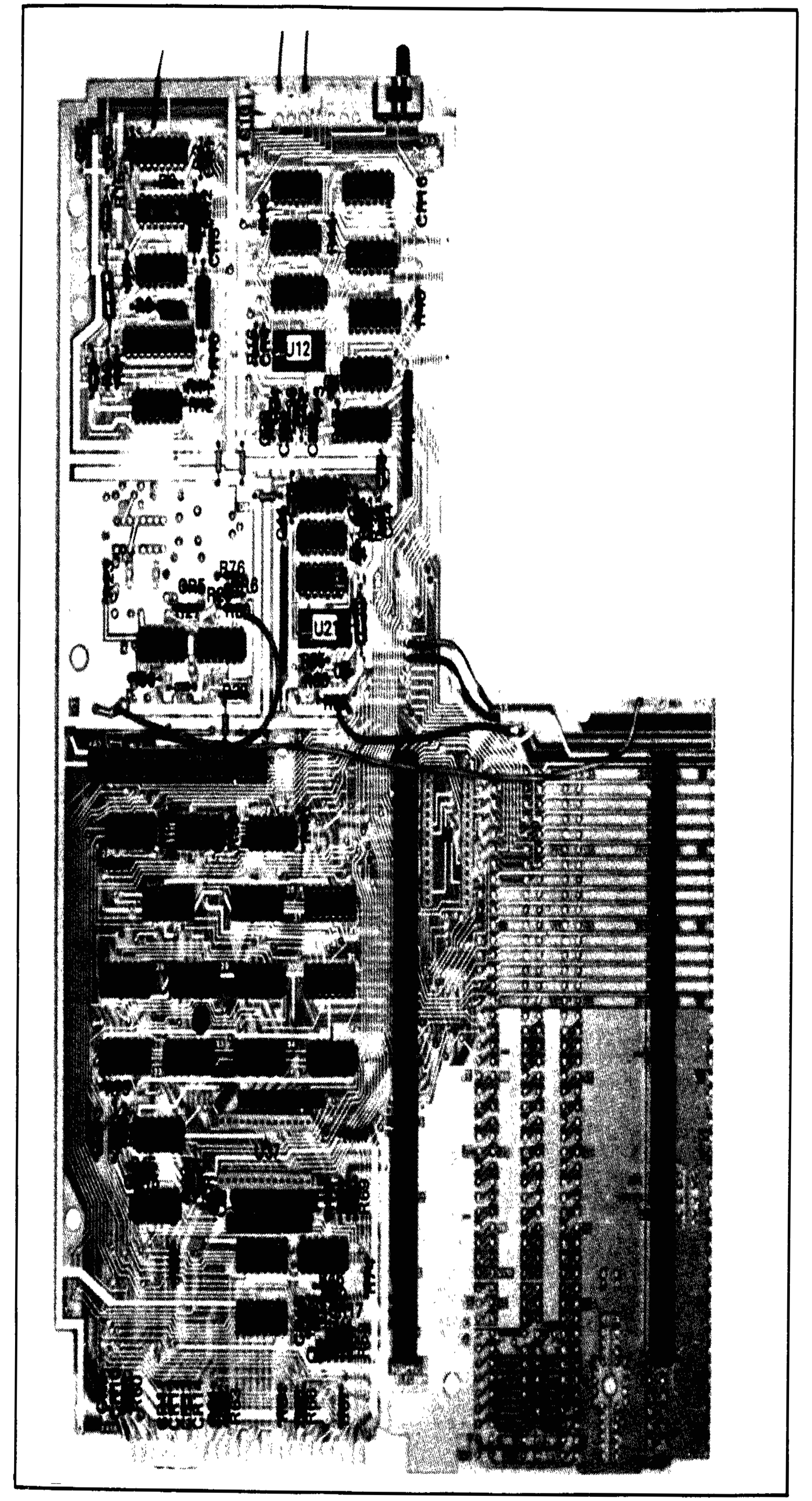
DIGIT ADDRESS	BUS LINE NO.
A	$\overline{45}$
B	45
C	$\overline{44}$
D	44

.5V/DIV 1 ms/DIV



DATA	BUS LINE NO.
A	$\overline{43}$
B	43
C	$\overline{42}$
D	42

P/O Figure 8-7. A1 Motherboard Assembly



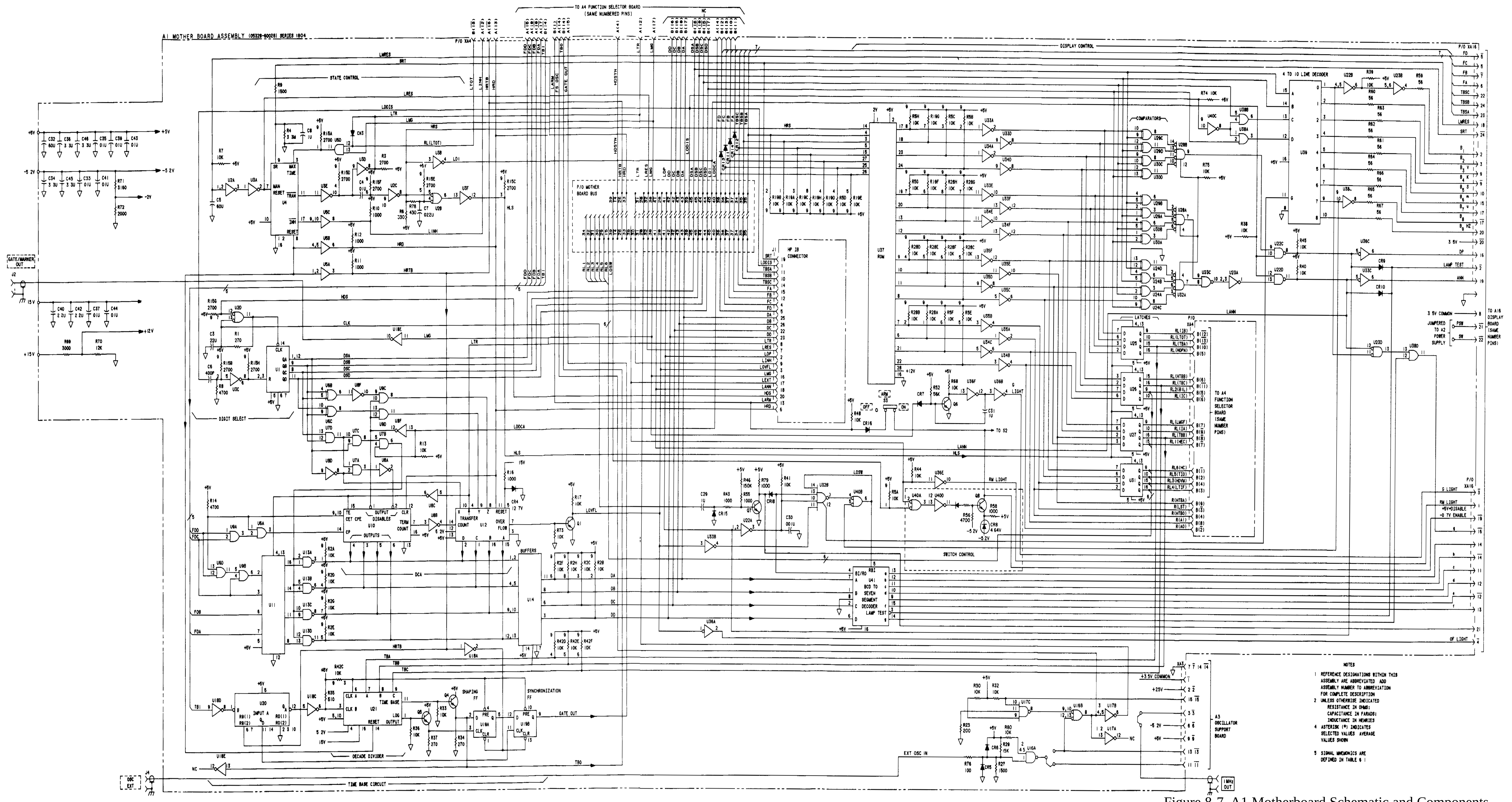
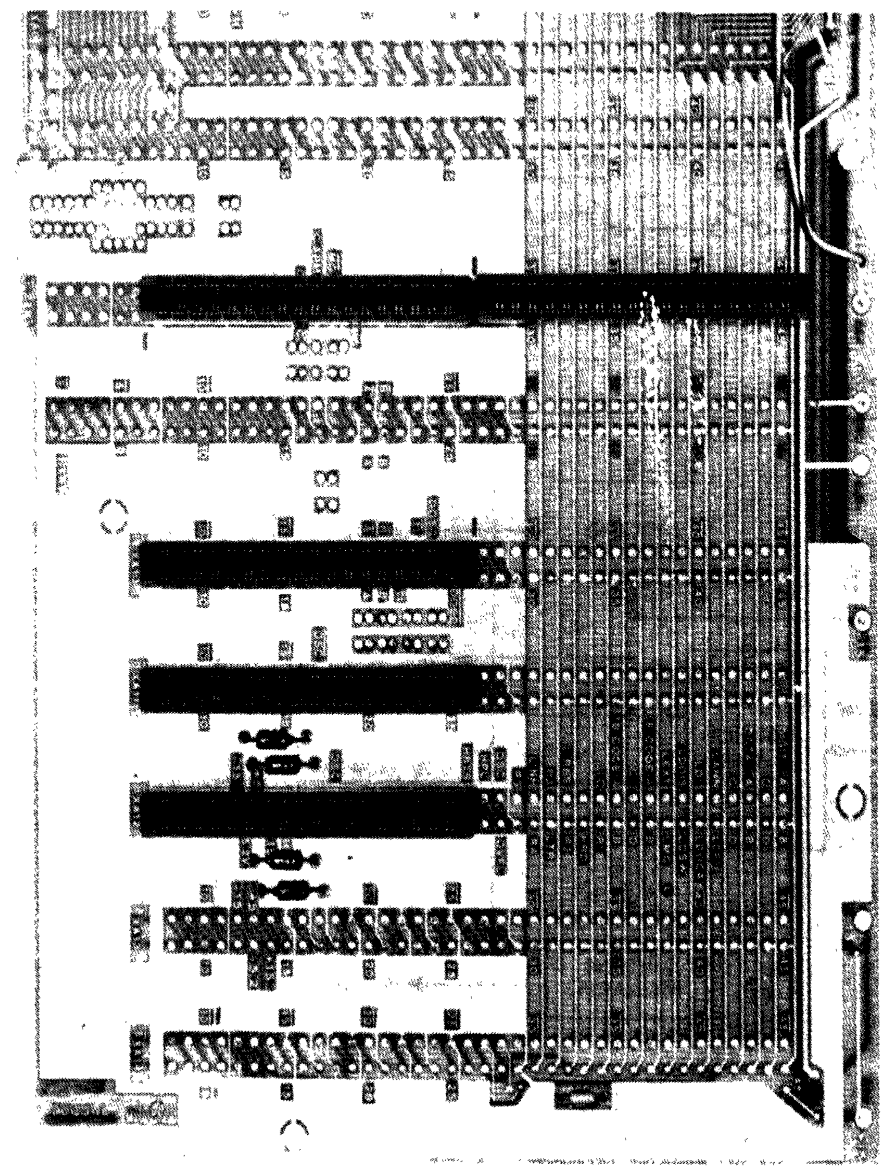


Figure 8-7. A1 Motherboard Schematic and Components
(Sheet 1 of 2)



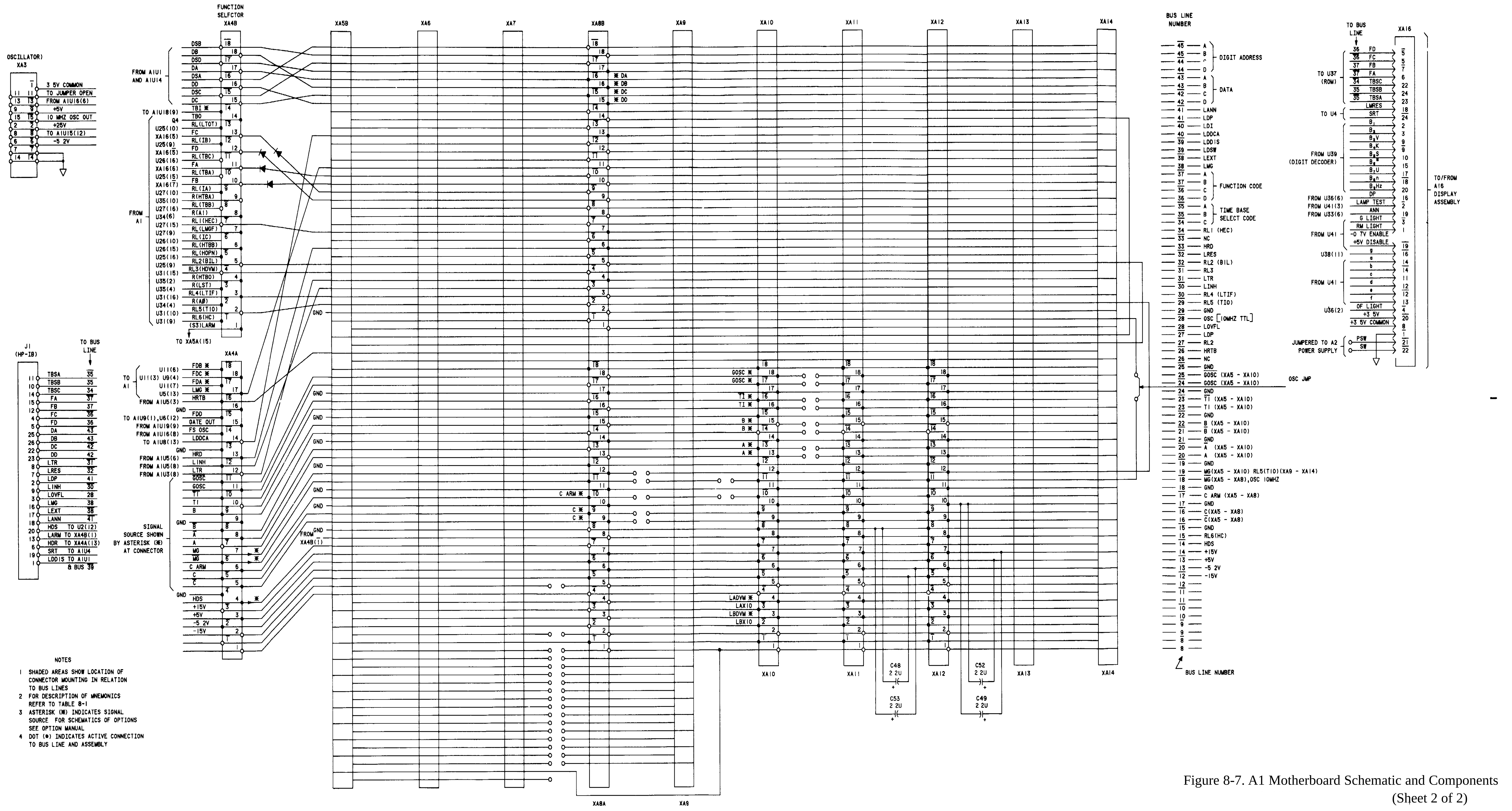


Figure 8-7. A1 Motherboard Schematic and Components (Sheet 2 of 2)

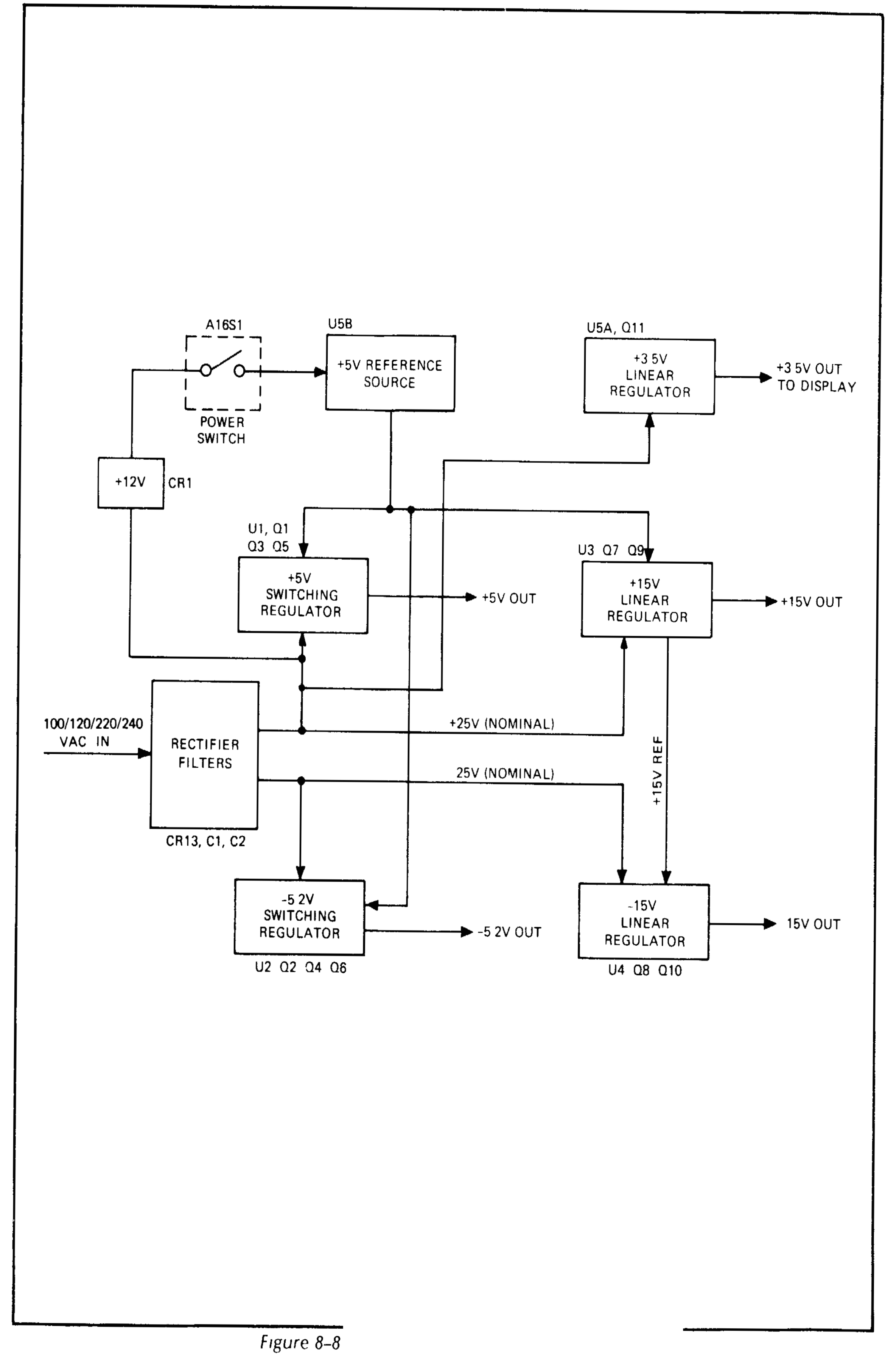
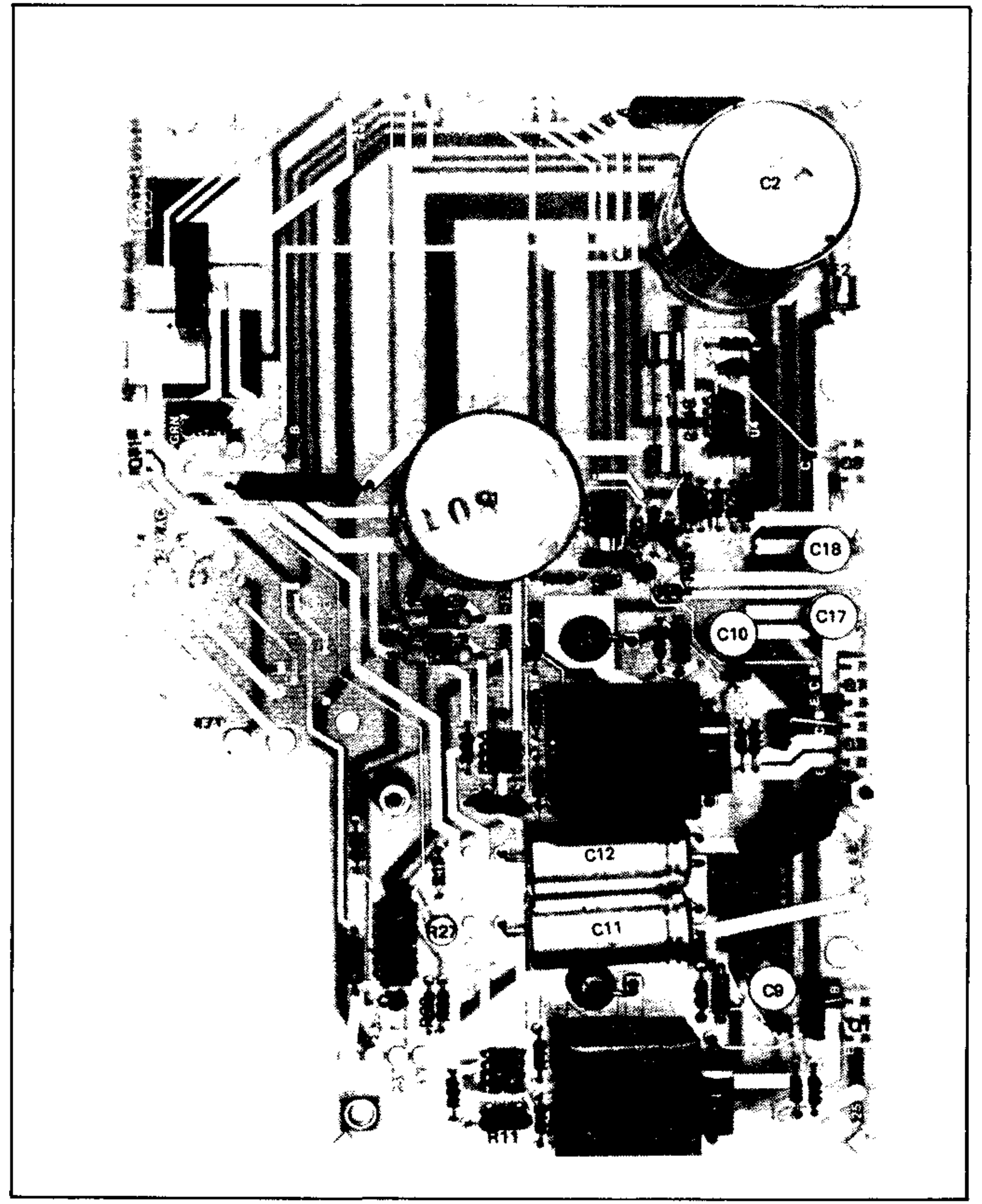


Figure 8-8

8-18

Figure 8-8. A2 Power Supply Block Diagram



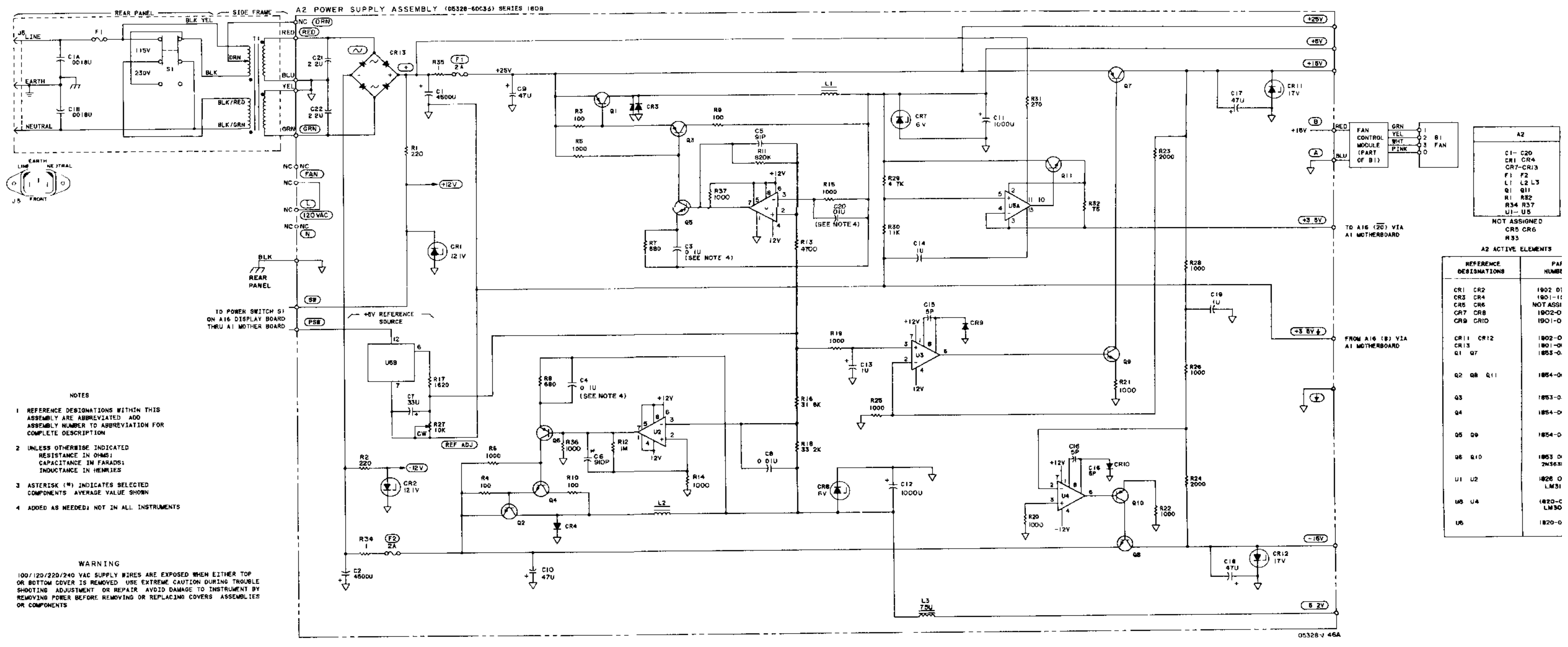
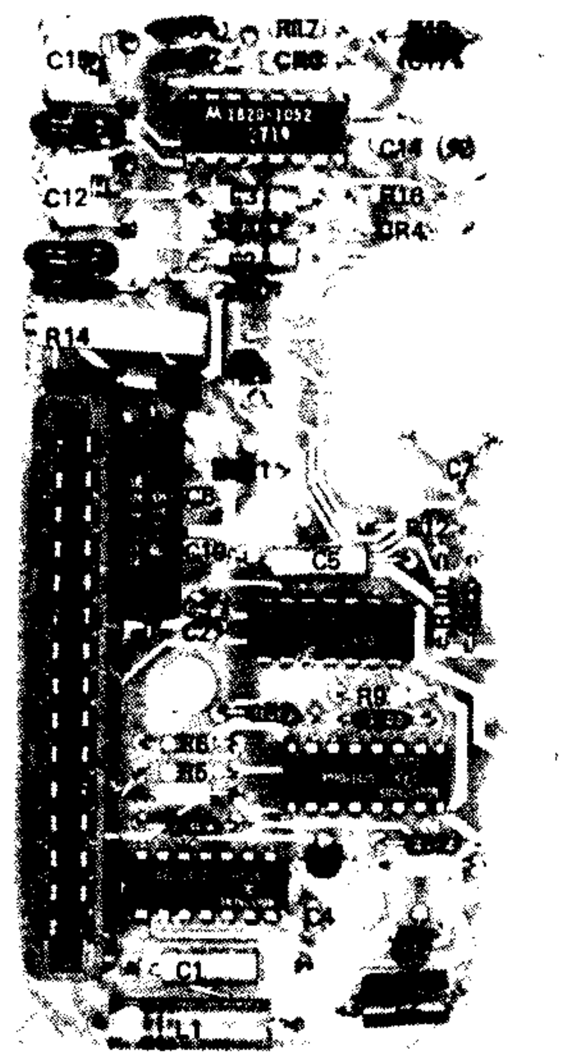


Figure 8-9. A2 Power Supply Schematic and Components



P/O Figure 8-10. A3/A3A1 Oscillator Support Schematic and Components



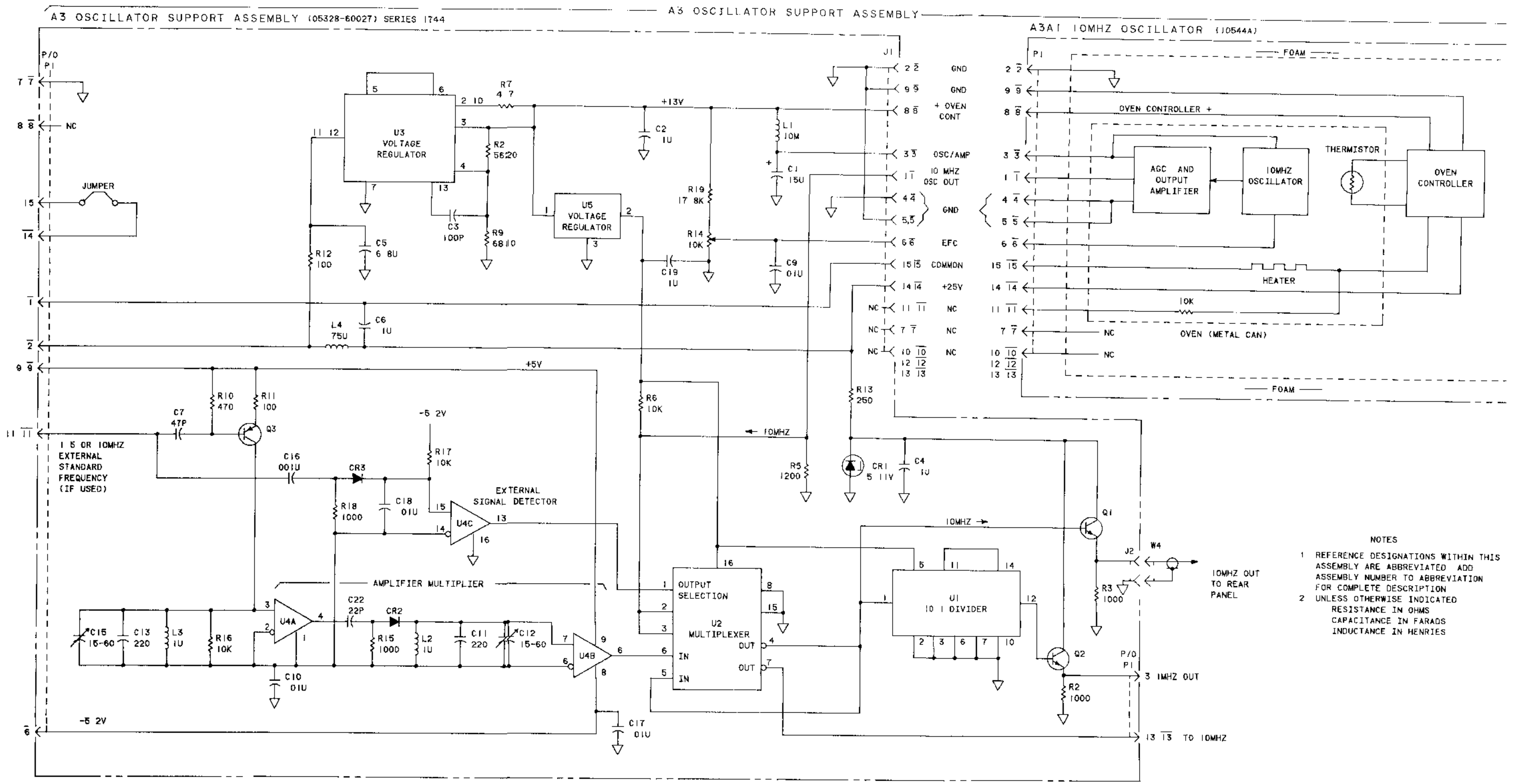


Figure 8-10. A3/A3A1 Oscillator Support Schematic and Components

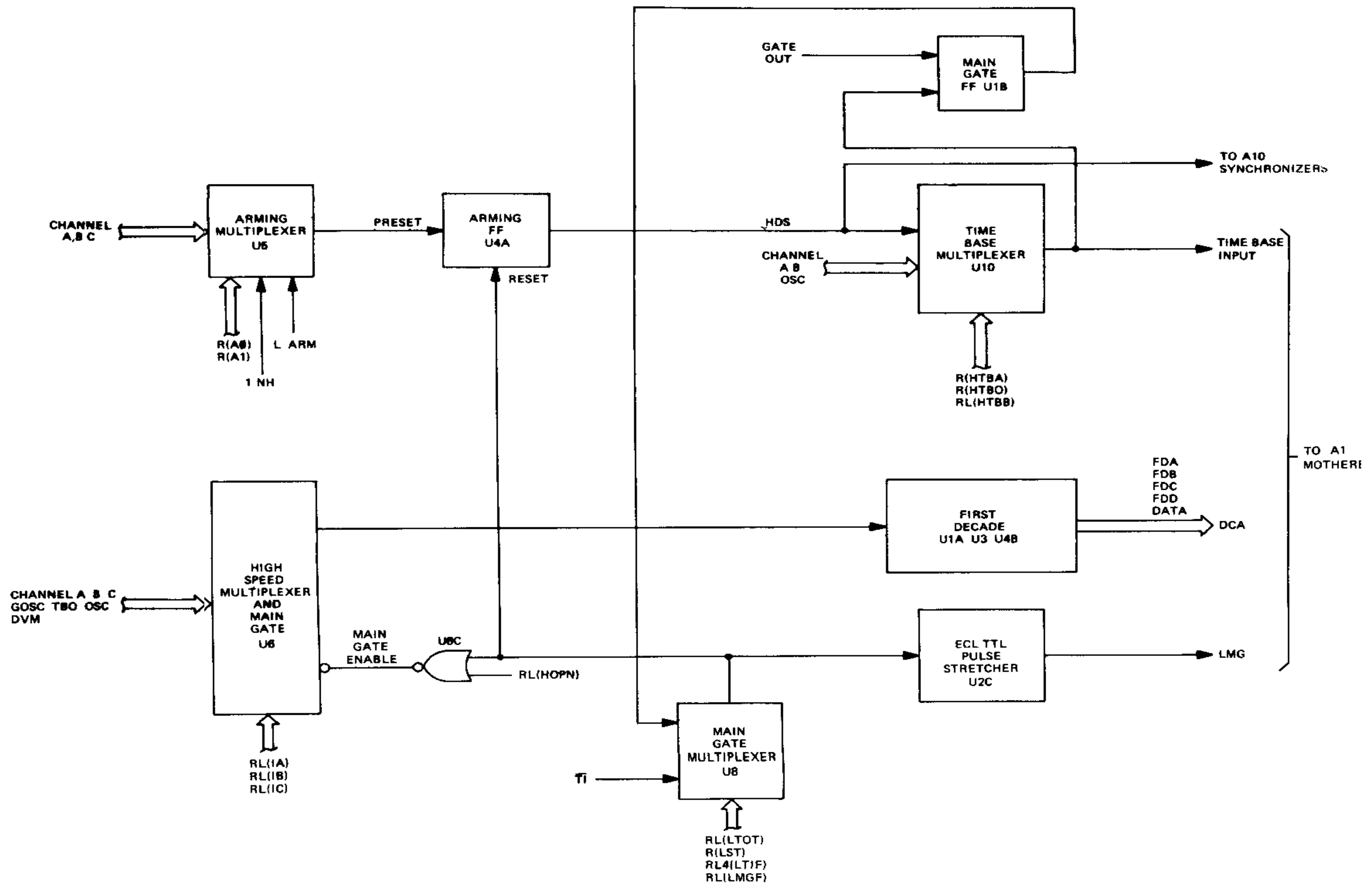


Figure 8-11. A4 Function Selector Block Diagram

P1A PINS

1	—	$\overline{DVM}$	$\overline{1}$	—	DVM
2	—	-15V	$\overline{2}$	—	-5 2V
3	—	+5V	$\overline{3}$	—	+15V
4	—	HDS*	$\overline{4}$	—	GND
5	—	$\overline{C}$	$\overline{5}$	—	C
6	—	C ARM	$\overline{6}$	—	$\overline{MG}$*
7	—	MG*	$\overline{7}$	—	A
8	—	$\overline{A}$	$\overline{8}$	—	$\overline{B}$
9	—	GND	$\overline{9}$	—	B
10	—	TI	$\overline{10}$	—	$\overline{TI}$
11	—	GOSC	$\overline{11}$	—	$\overline{GOSC}$
12	—	LTR	$\overline{12}$	—	GND
13	—	HRD	$\overline{13}$	—	FS OSC
14	—	LDDCA	$\overline{14}$	—	FS OSC
15	—	GATE OUT	$\overline{15}$	—	FDD*
16	—	GND	$\overline{16}$	—	HRTB
17	—	LMG*	$\overline{17}$	—	FDA*
18	—	FDC*	$\overline{18}$	—	FDB*

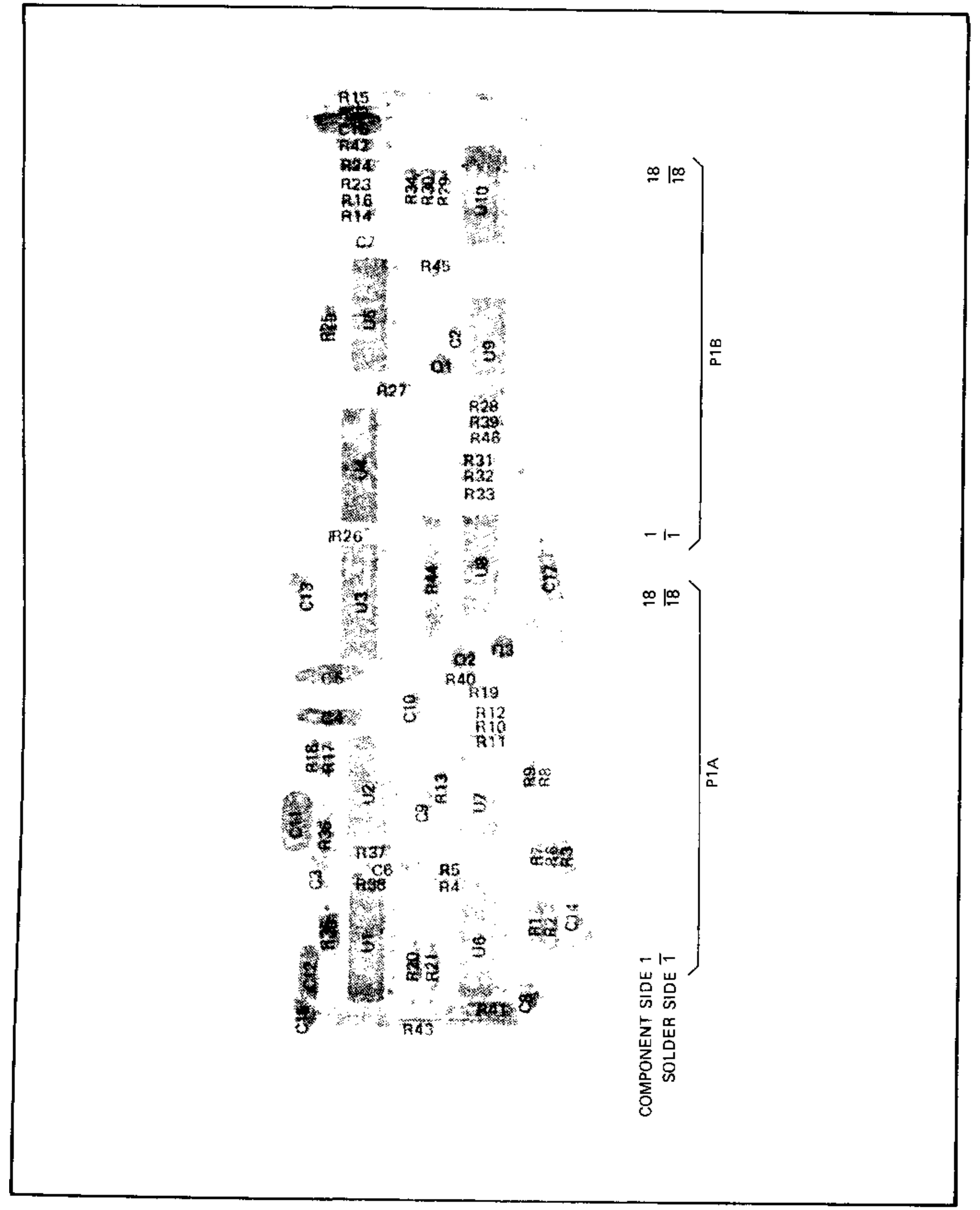
*SIGNAL SOURCE

P1B PINS

1	—	L ARM		$\overline{1}$	—	RL6(HC)	
2	—	RL5(TIO)		$\overline{2}$	—	R(AØ)	
3	—	RL4(LTIF)		$\overline{3}$	—	R(LST)	
4	—	R(HTBO)		$\overline{4}$	—	RL3(HDV	
5	—	RL2(BIL)		$\overline{5}$	—	RL(HOPN	
6	—	RL(HTBB)		$\overline{6}$	—	RL(IC)	
7	—	RL(LMGF)		$\overline{7}$	—	RL1(HEC	
8	—	R(A1)		$\overline{8}$	—	RL(TBB)	
9	—	R(HTBA)		$\overline{9}$	—	RL(IA)	
10	—	FB	NC	$\overline{10}$	—	RL(TBA)	
11	—	FA	NC	$\overline{11}$	—	RL(TBC)	
12	—	FD	NC	$\overline{12}$	—	RL(IB)	
13	—	FC	NC	$\overline{13}$	—	RL(LTOT	
14	—	TBO	NC	$\overline{14}$	—	TBI*	
15	—	DATA C	NC	$\overline{15}$	—	DS C	
16	—	DATA D	NC	$\overline{16}$	—	DS A	
17	—	DATA A	NC	$\overline{17}$	—	DS D	
18	—	DATA B	NC	$\overline{18}$	—	DS B	

*SIGNAL SOURCE

P/O Figure 8-12. A4 Function Selector Assembly



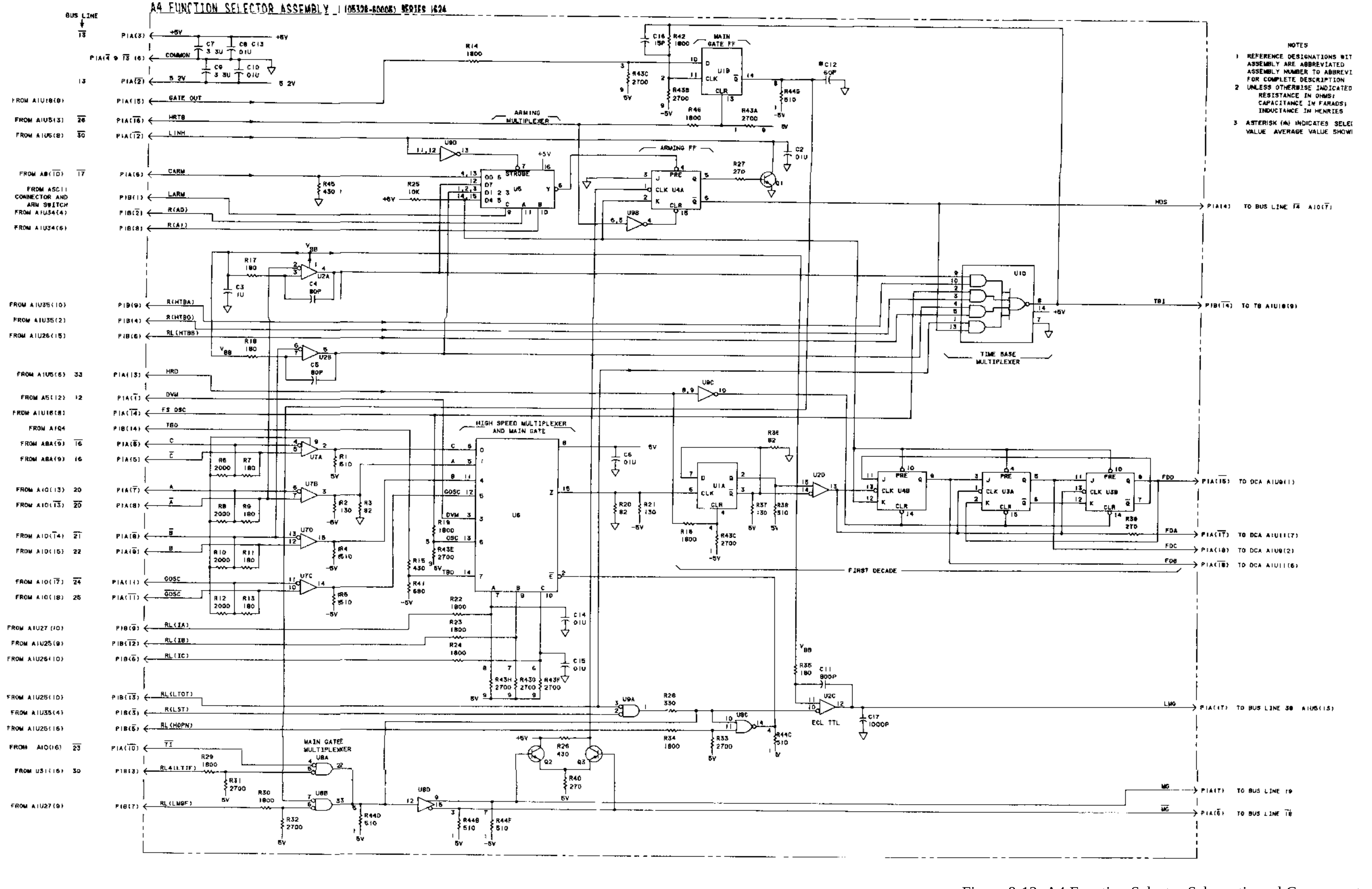


Figure 8-12. A4 Function Selector Schematic and Components

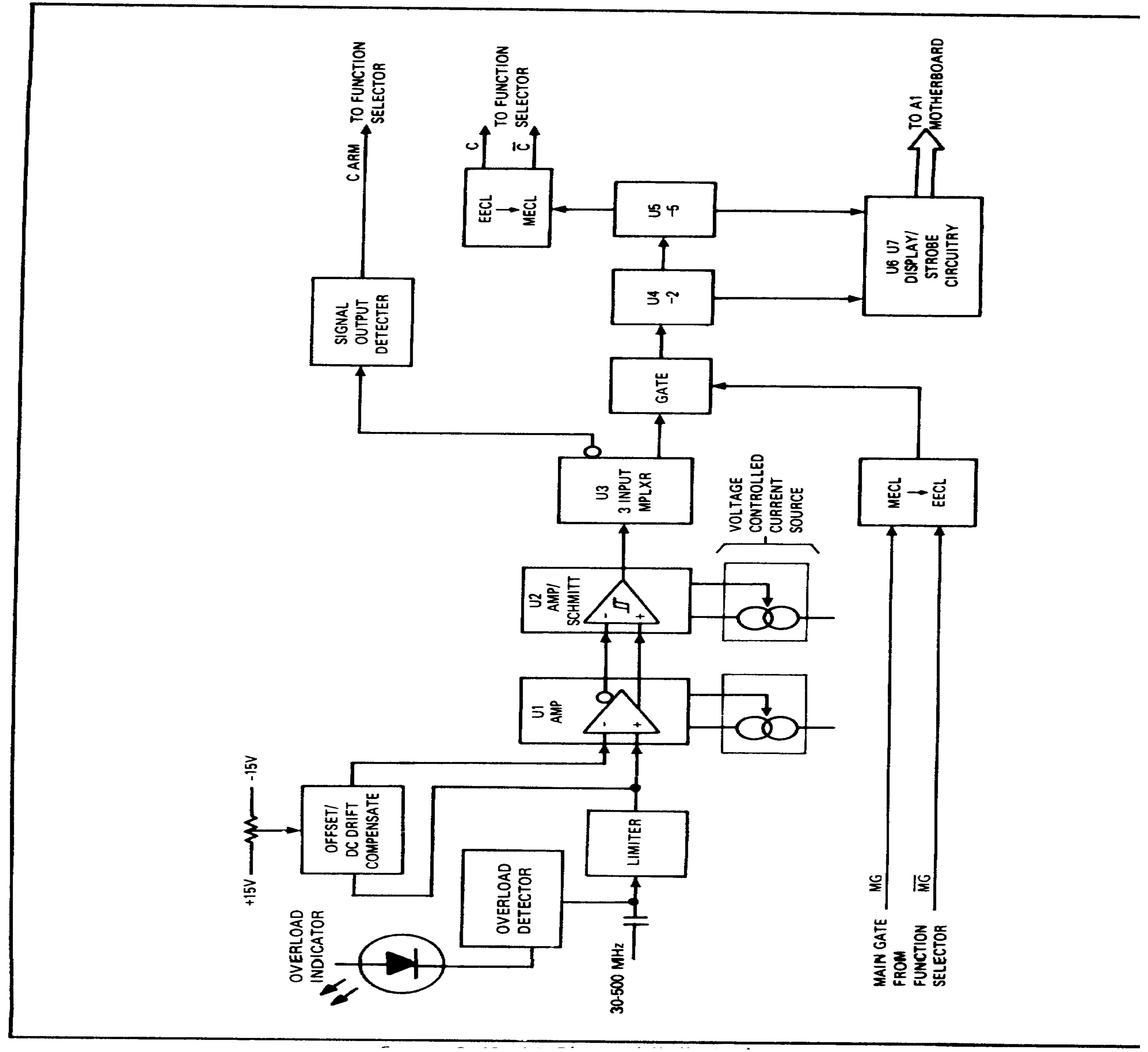
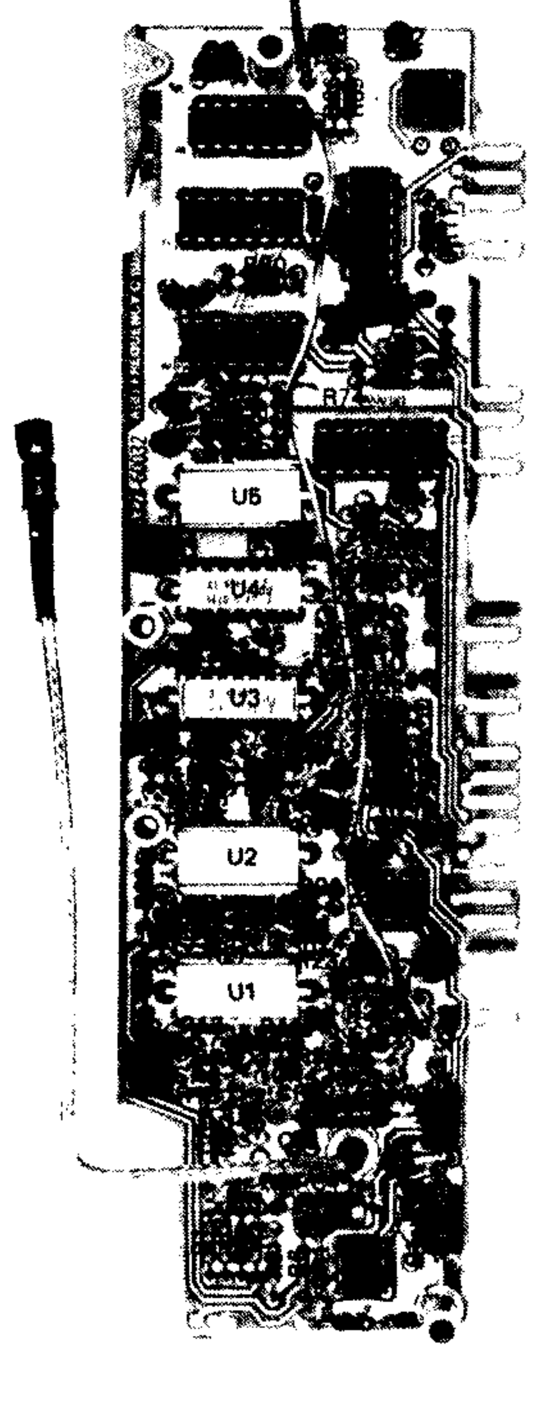


Figure 8-13. A8 Channel "C" Block Diagram



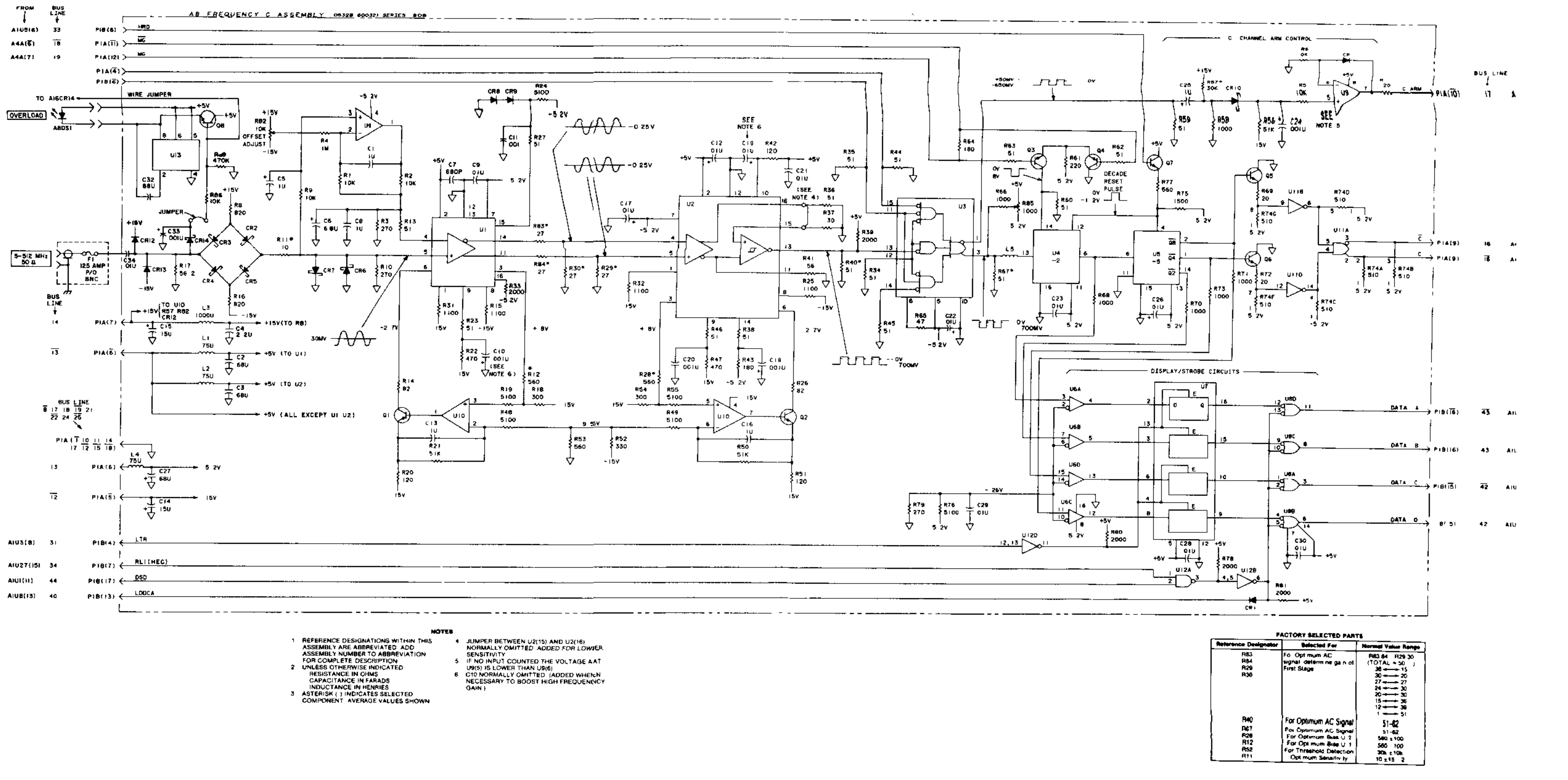


Figure 8-14. A8 Channel "C"Schematic and Components

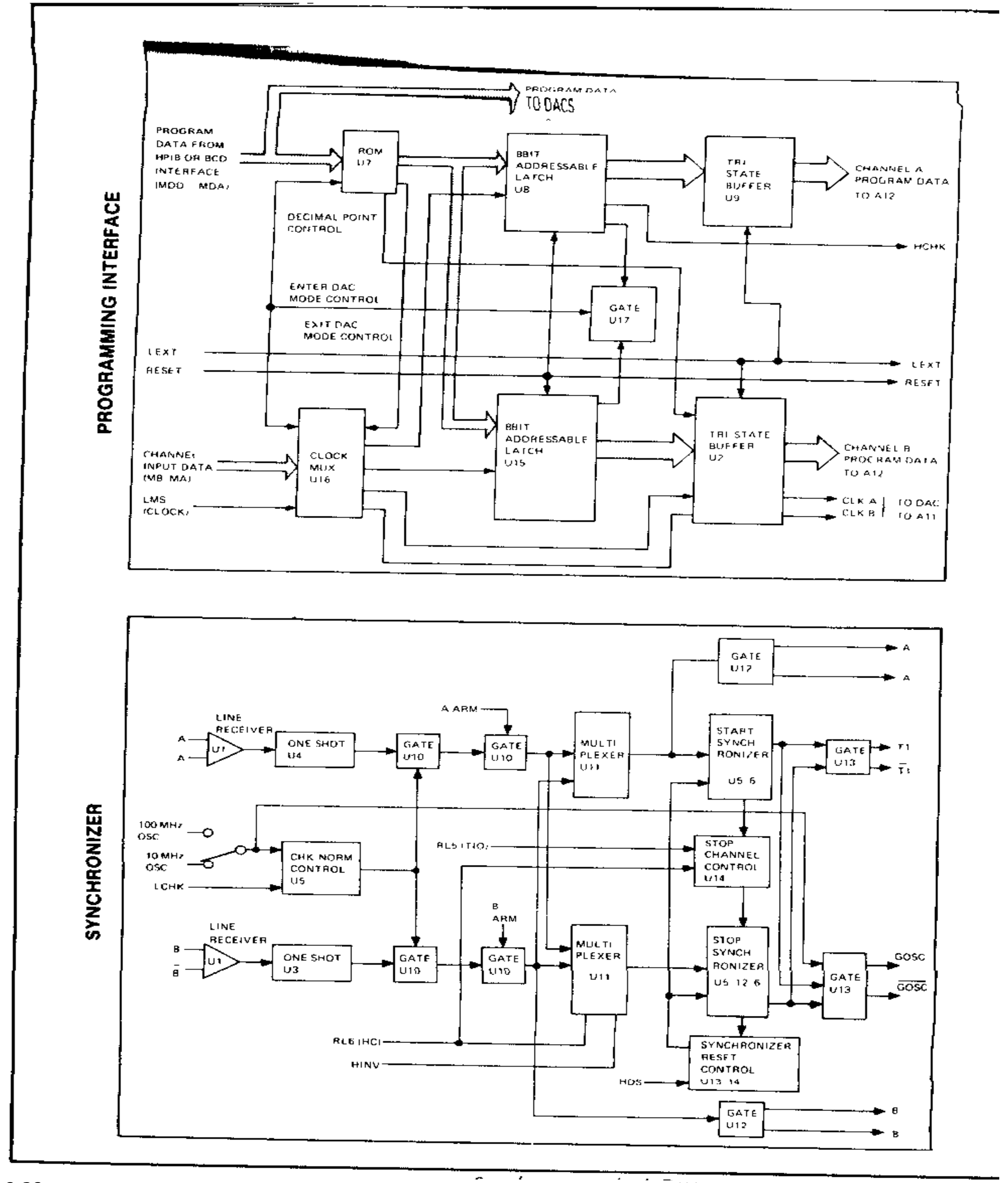
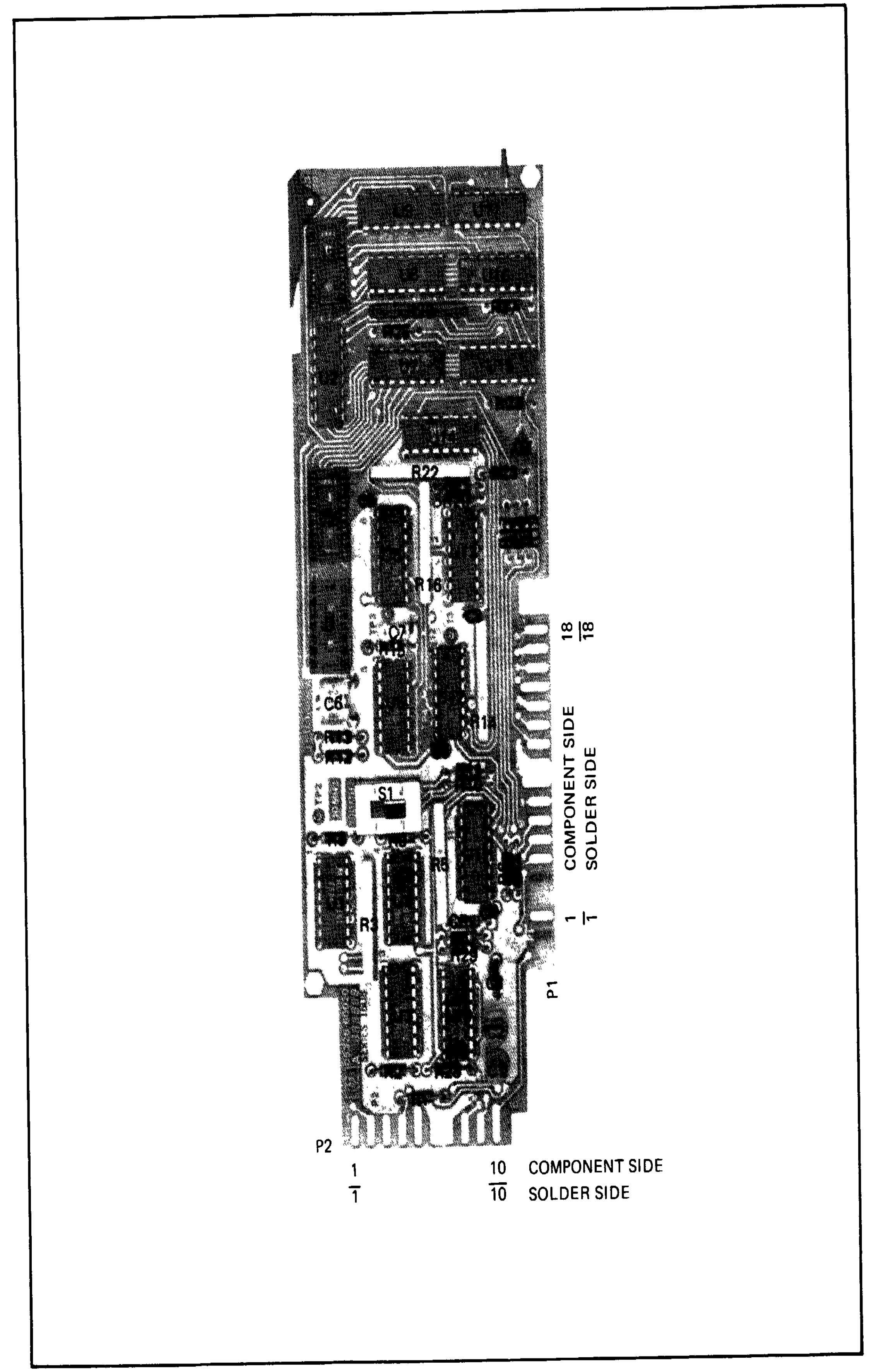


Figure 8-15. A10 Synchronizer Block Diagram



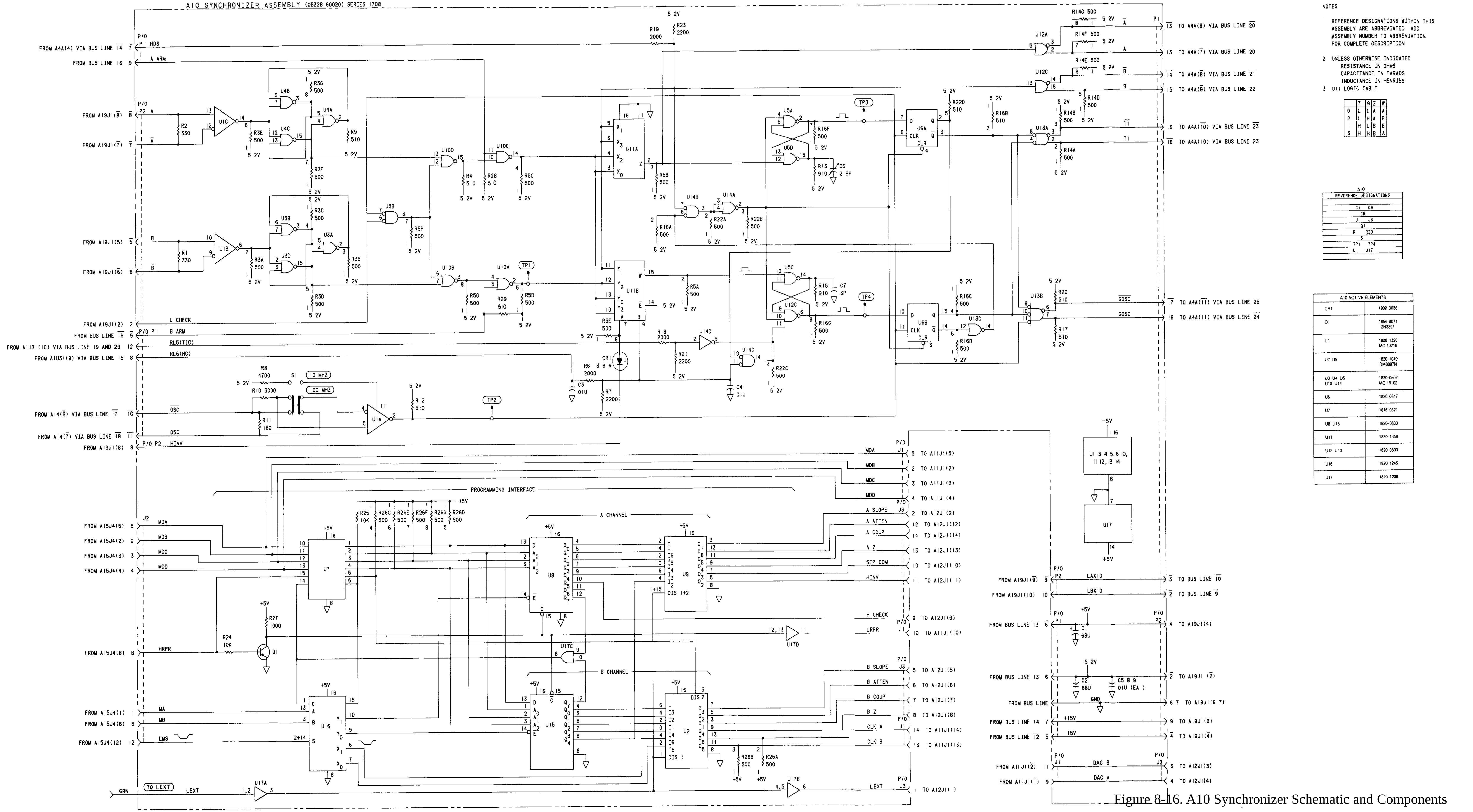


Figure 8-16. A10 Synchronizer Schematic and Components

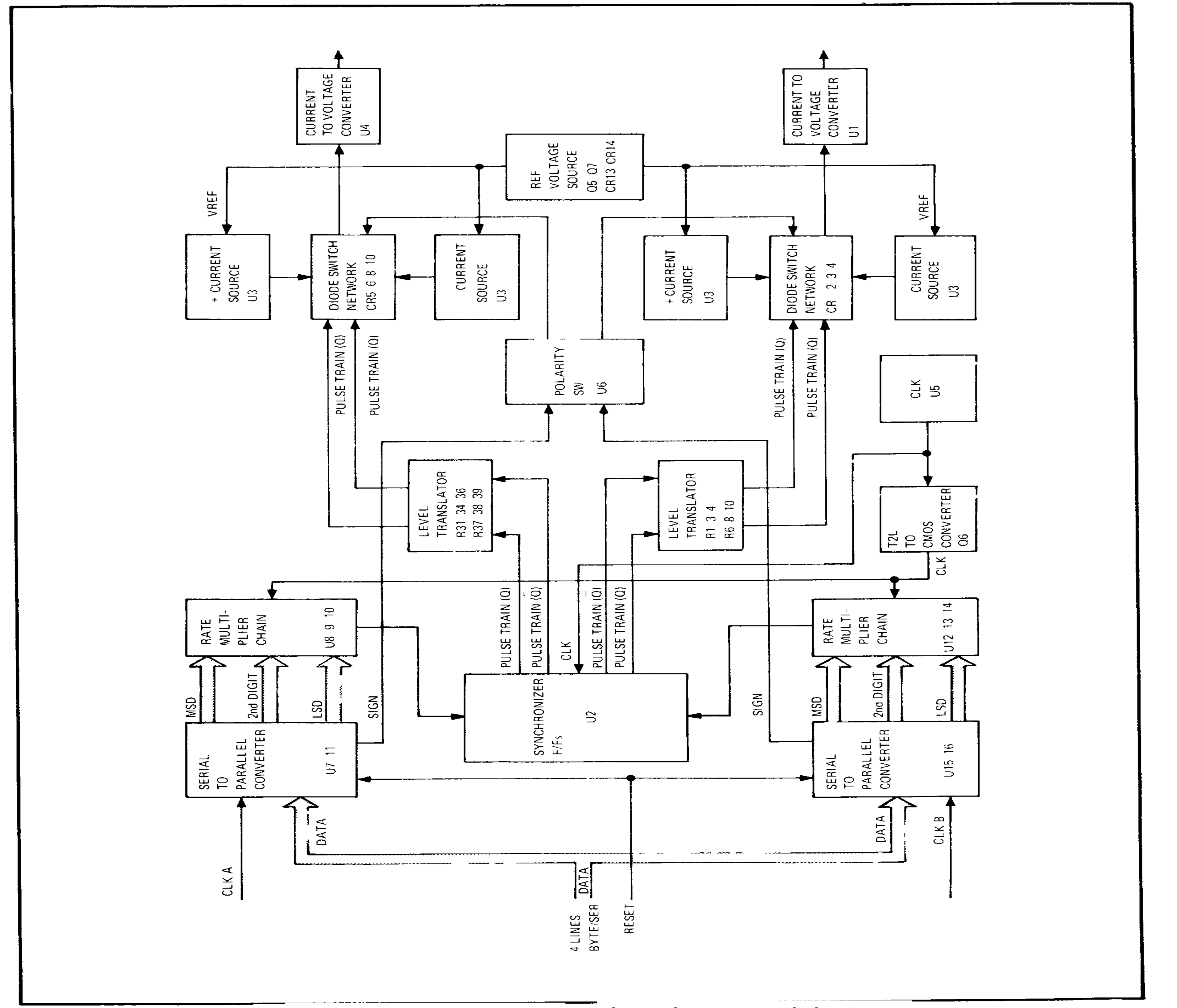
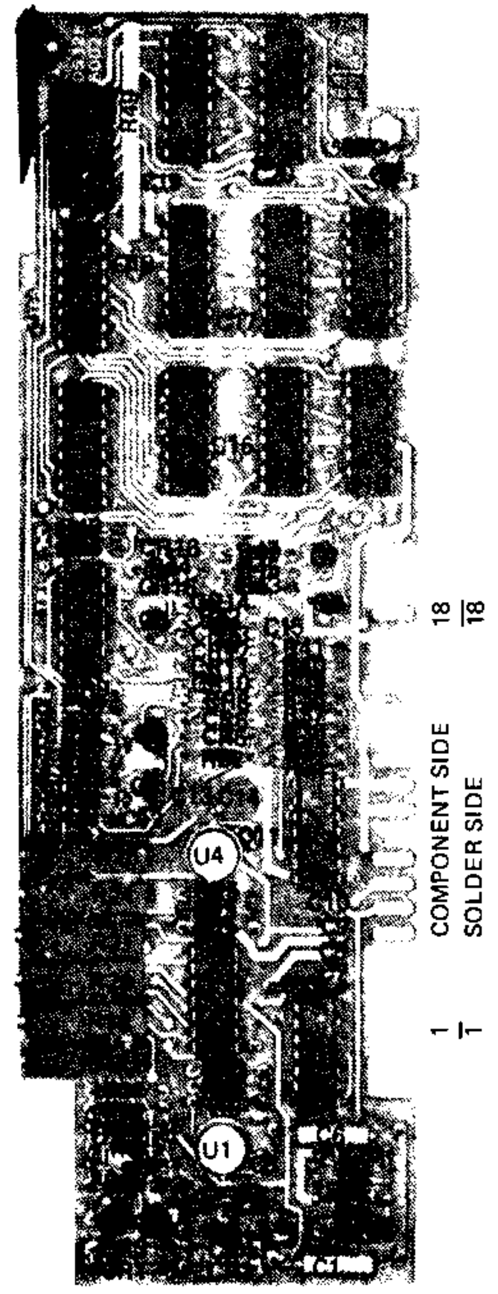
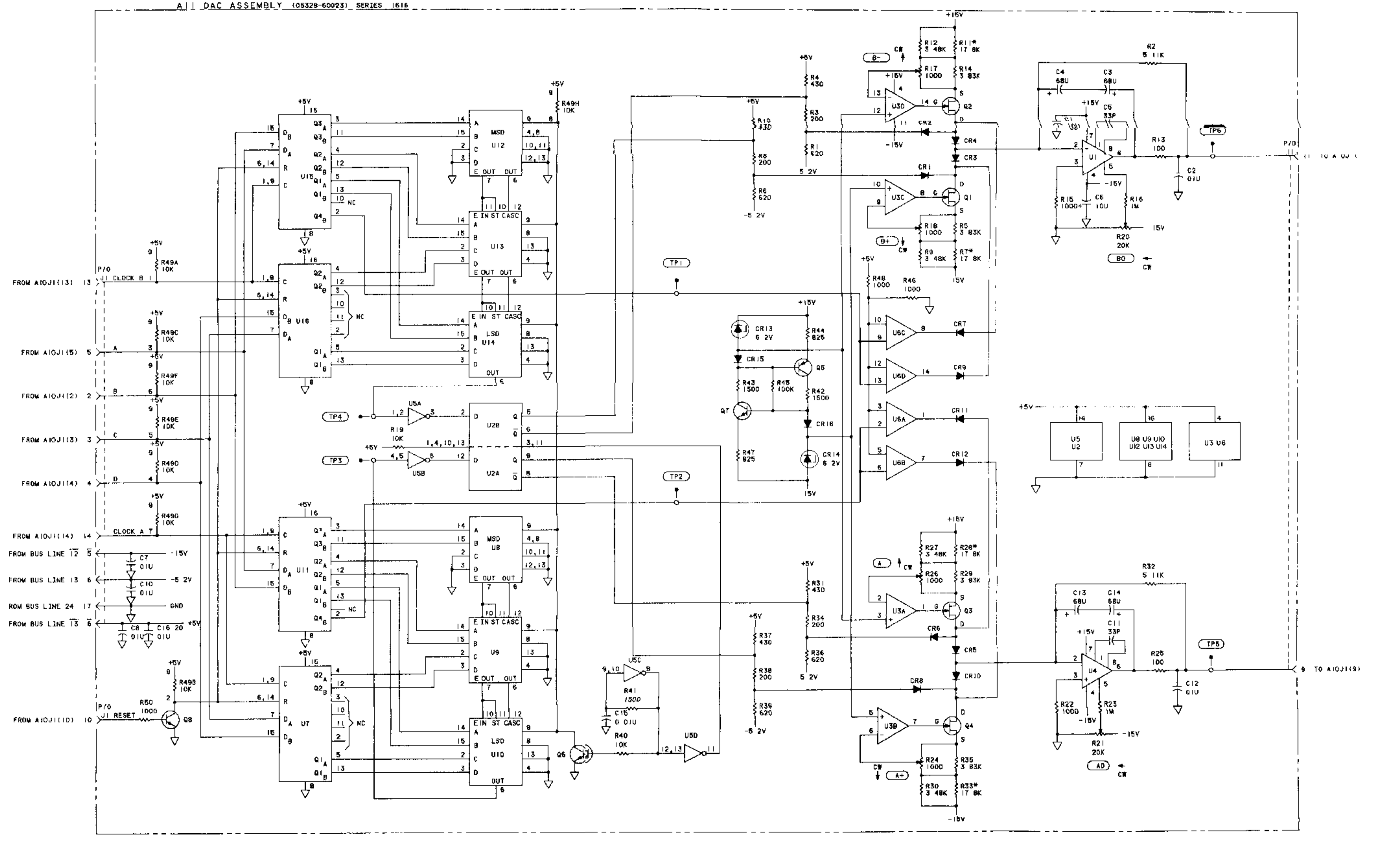


Figure 8-17. A11 Digital-to-Analog Converter Block Diagram





NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN FARADS; INDUCTANCE IN HENRIES.
3. ASTERISK (*) INDICATES SELECTED VALUE. AVERAGE VALUE SHOWN.

A11

REFERENCE DESIGNATIONS
C1-C20
CR1-CR16
J1
Q1-Q8
R1-R50
TP1-TP6
U1-U16

ALL ACTIVE ELEMENTS	
CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8 CR9 CR10 CR11 CR12	1901-0179
CR13 CR14	1902-0680
CR15 CR16	1901-0040
Q1 Q4	1855-0081 2N5245
Q2 Q3	1855-0416
Q6 Q7 Q8	1854-0071 2N3391
U1 U4	1826-0059 LM201A
U2	1820-0693 SN74S74N
U3 U6	1826-0161 LM324
U5	1820-1425 SN74LS132N
U7 U11 U15 U16	1820-0976 CD4015AE
U8 U9 U10 U12 U13 U14	1820-1265 MC14527CP

Figure 8-18. A11 Digital-to-Analog Converter Schematic and Components

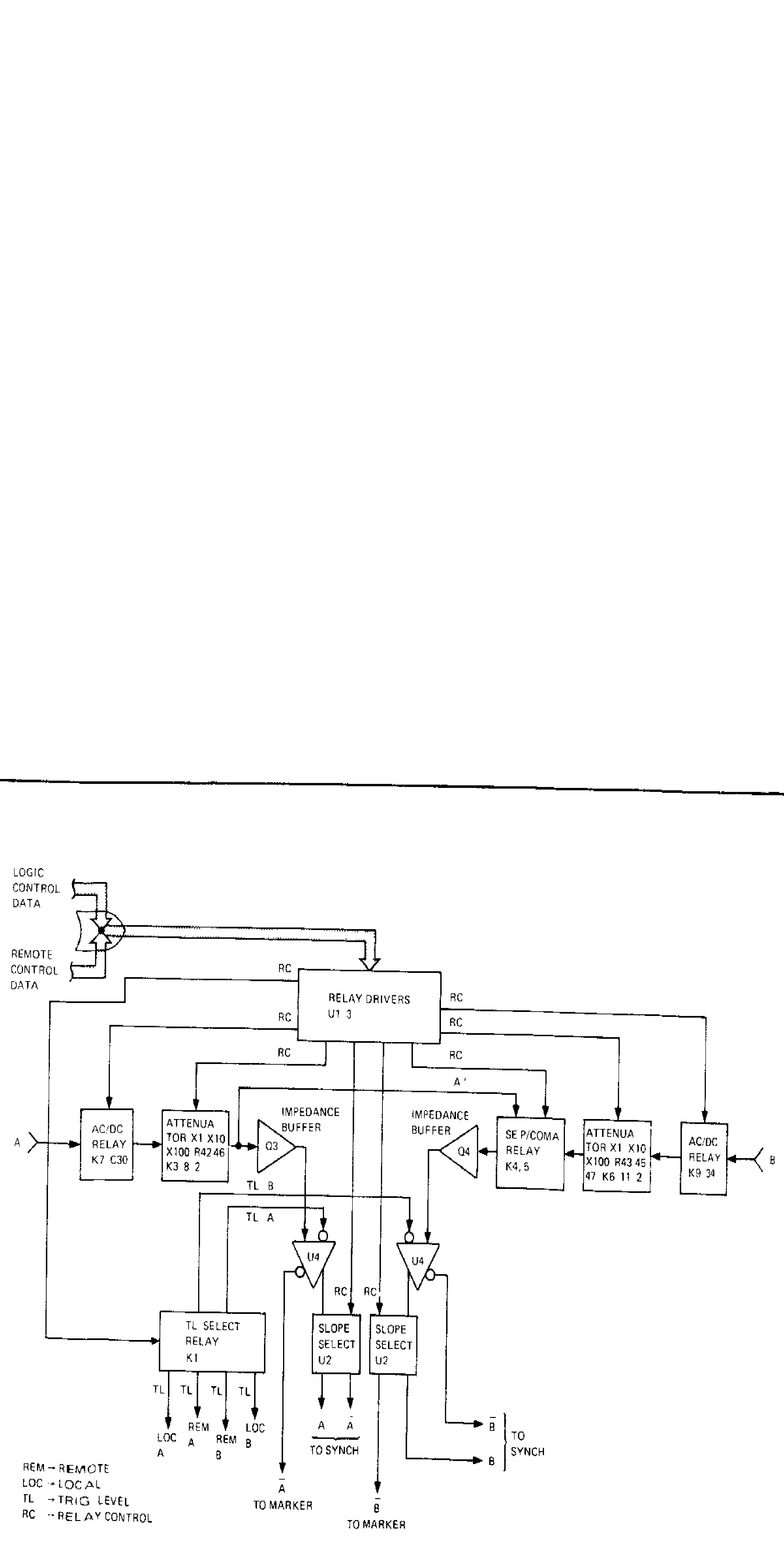
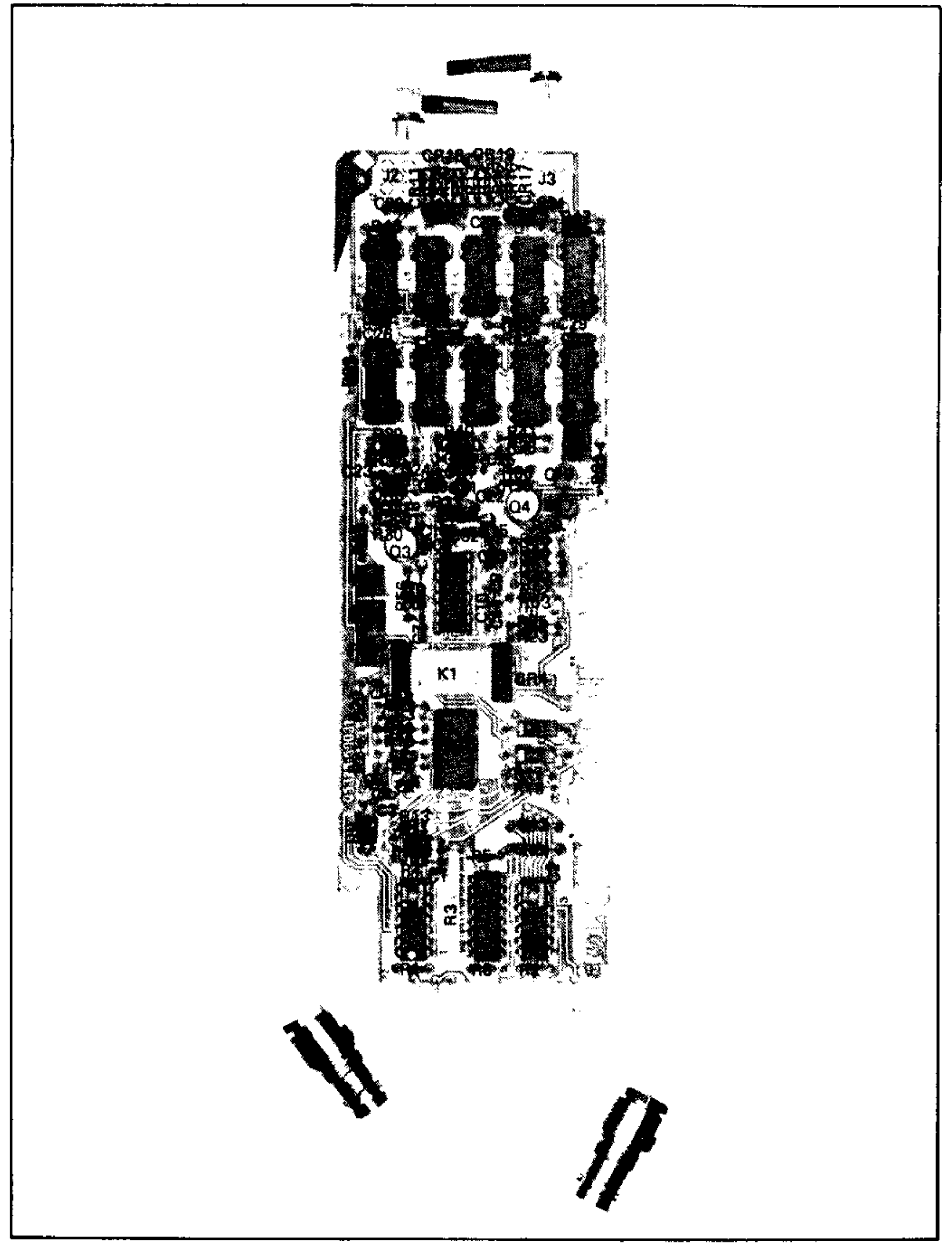


Figure 8-19. A12 "A-B" Channel Block Diagram



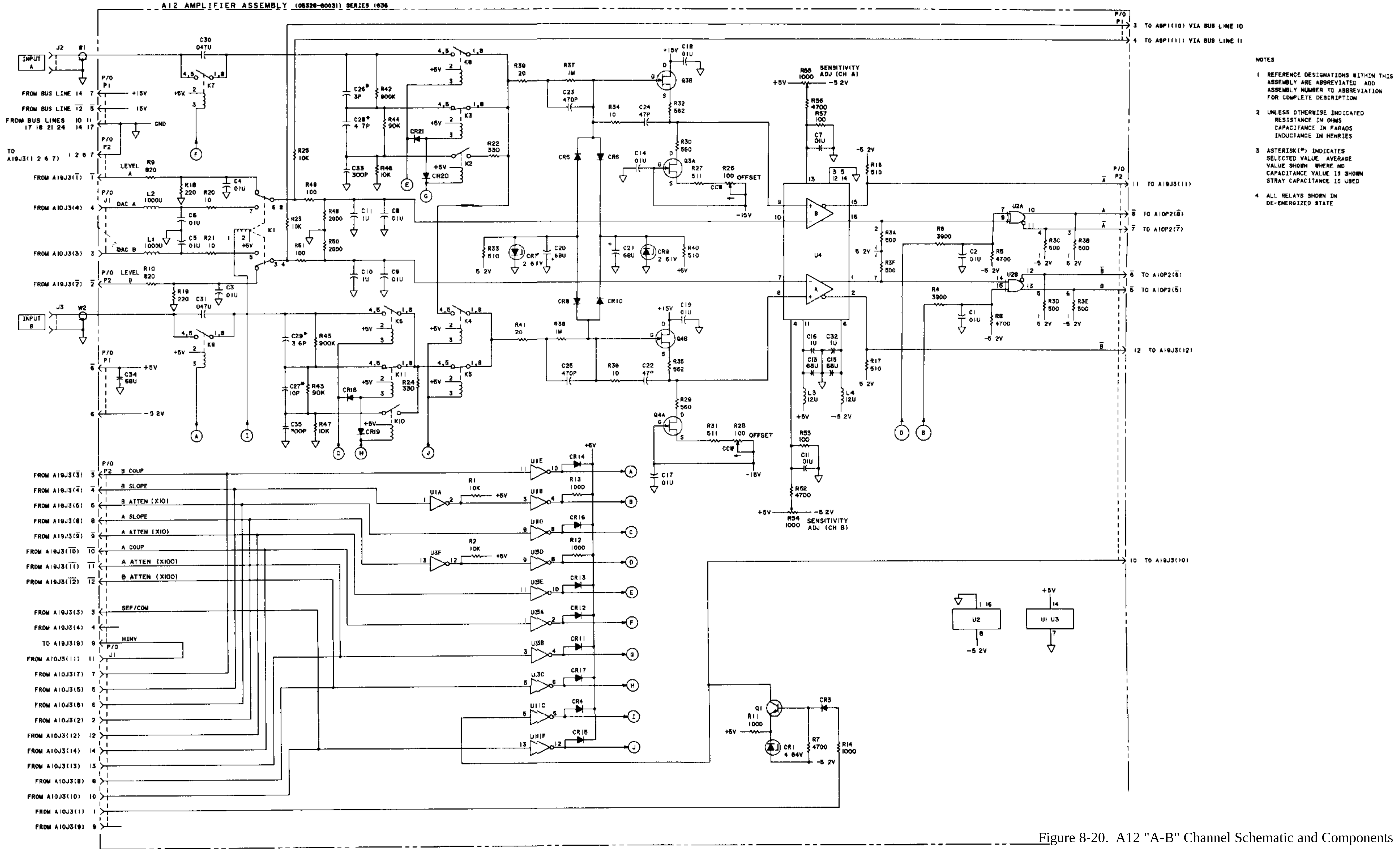


Figure 8-20. A12 "A-B" Channel Schematic and Components

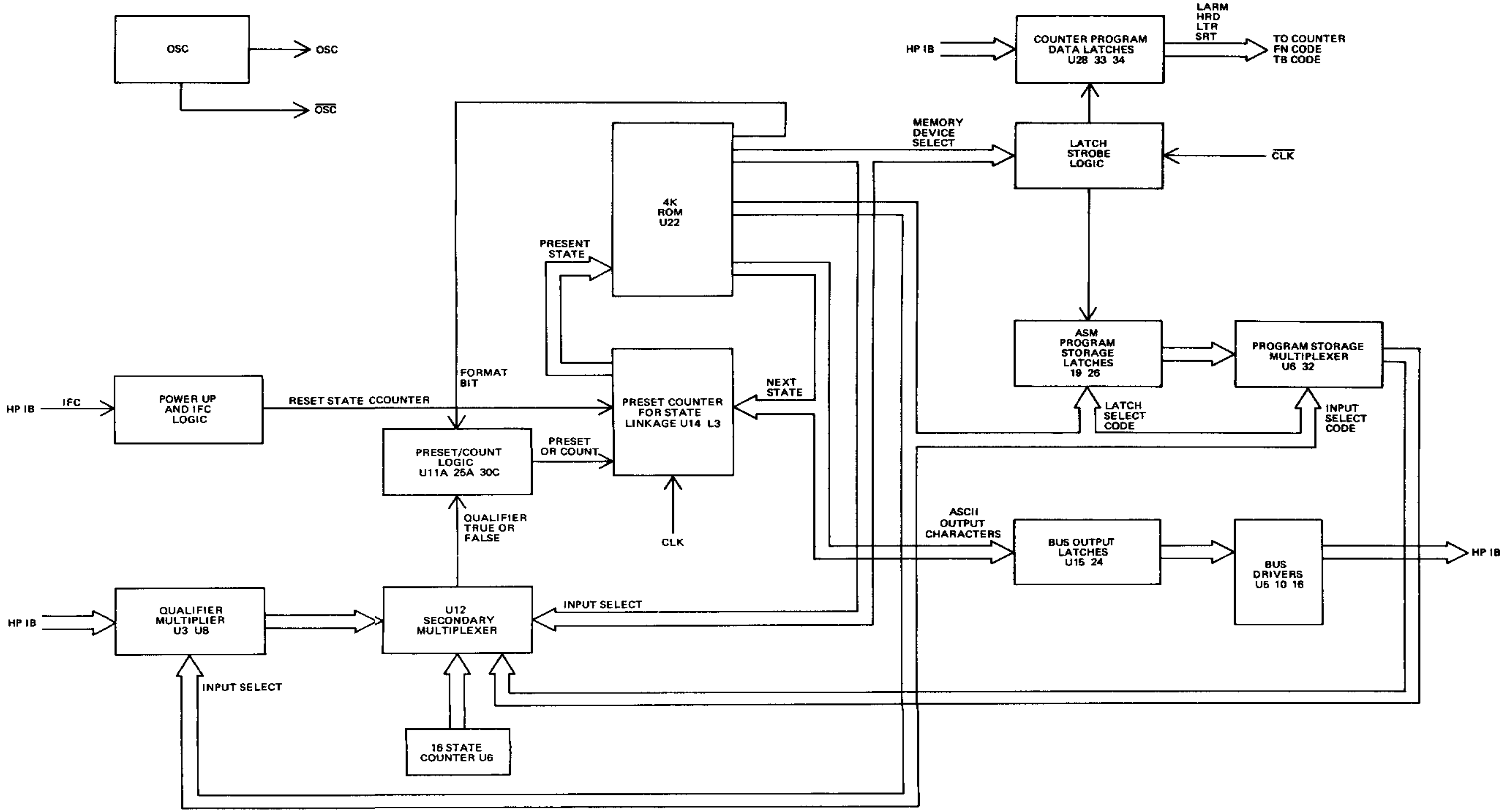
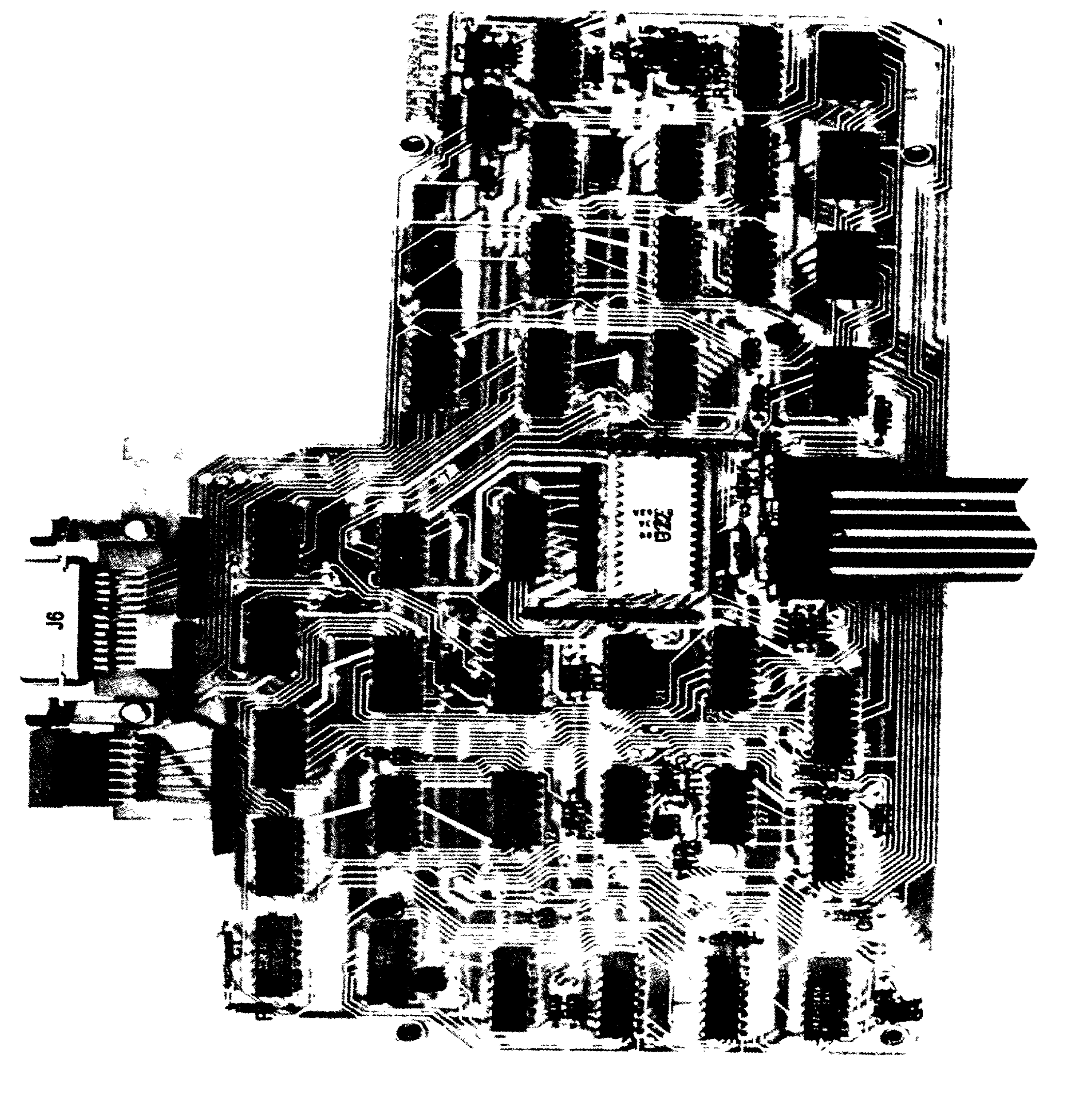


Figure 8-21. A15 HP-IB Interface Block Diagram



P/O Figure 8-22. A15 HP-IB Interface Schematic and Components

Signals from A15J1 through Cable to A1J1 (Motherboard)

1 LDDIS → BUS (39)
2 LDP → BUS (41)
3 LOVFL → BUS (28)
4 FC → BUS (36) → XA16(5)
5 FD → BUS (36) → XA16(5)
6 HRD → BUS (33)
7 LRES → BUS (32)
8 LTR → BUS (31) → XA4A(12)
9 LINH → BUS (30)
10 TBSB → BUS (35) → XA16(24)
11 TBSA → BUS (35) → XA16(23)
12 FB → BUS (37) → XA16(7)
13 LARM → XA4B(1)
14 TBSC → BUS (34) → XA16(22)
15 FA → BUS (37) → XA16(6)
16 LMG → XA4(A17) → BUS (38)
17 LEXT → BUS (38)
18 LANN → BUS (41)
19 SRT → A1(U4) → XA16(24)
20 HDS → XA4A(4) → BUS (14)
21 +15V
22 DC → XA4(B15) → BUS (42)
23 DD → XA4(B16) → BUS (42)
24 +5V
25 DA → XA4(B17) → BUS (43)
26 DB → XA4(B18) → BUS (43)
27 GND
28 -5V

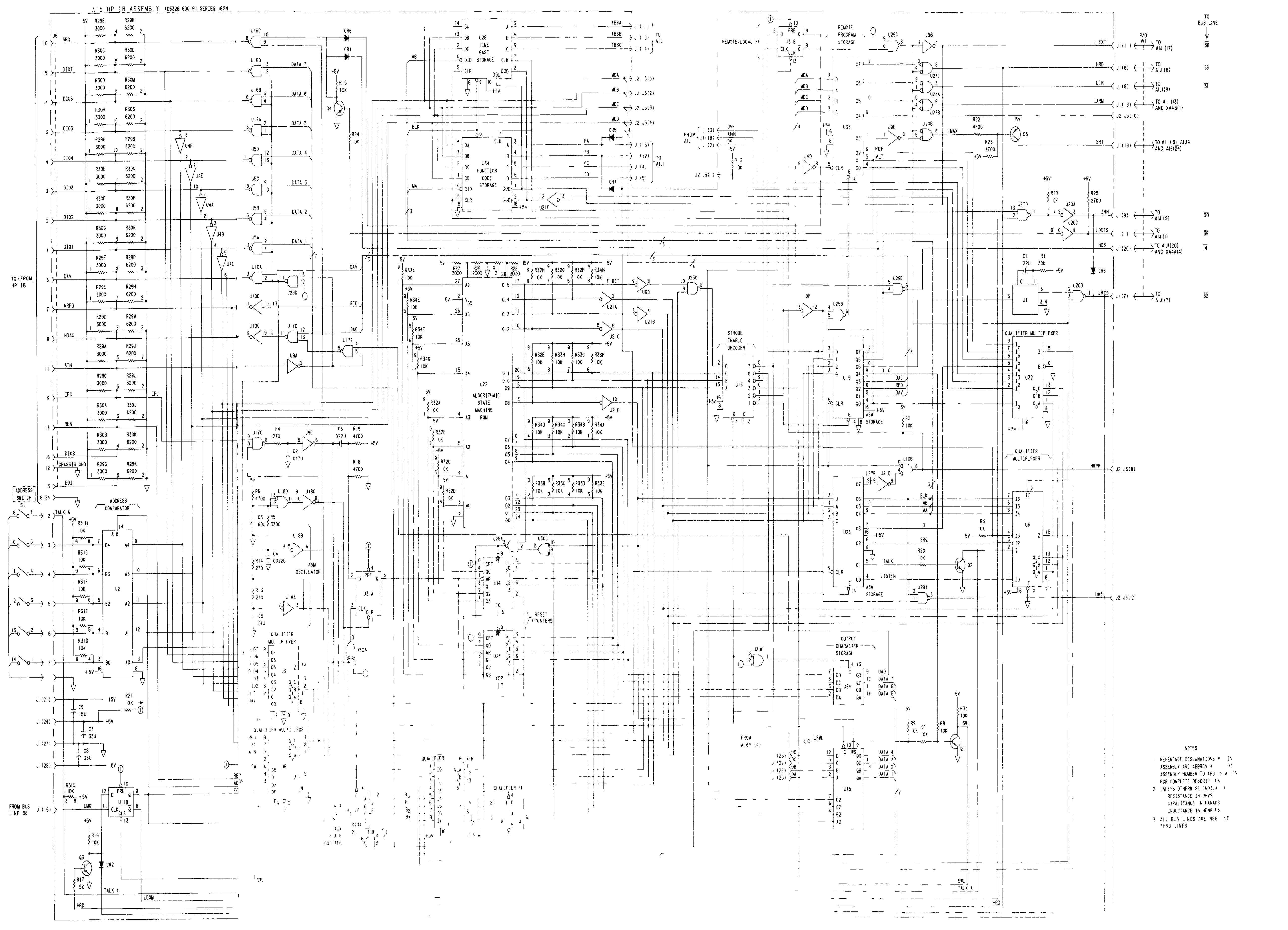


Figure 8-22. A15 HP-IB Interface Schematic and Components

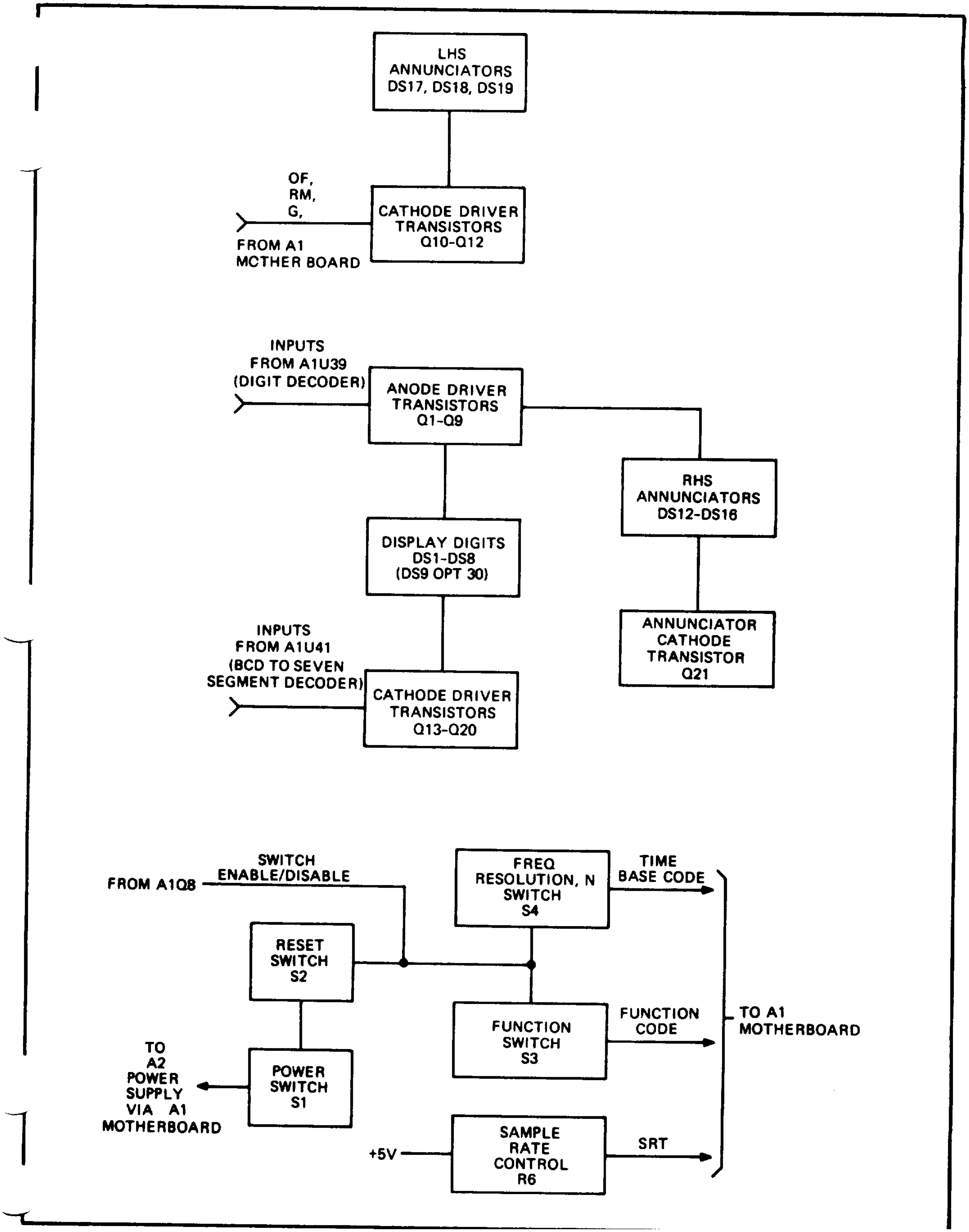
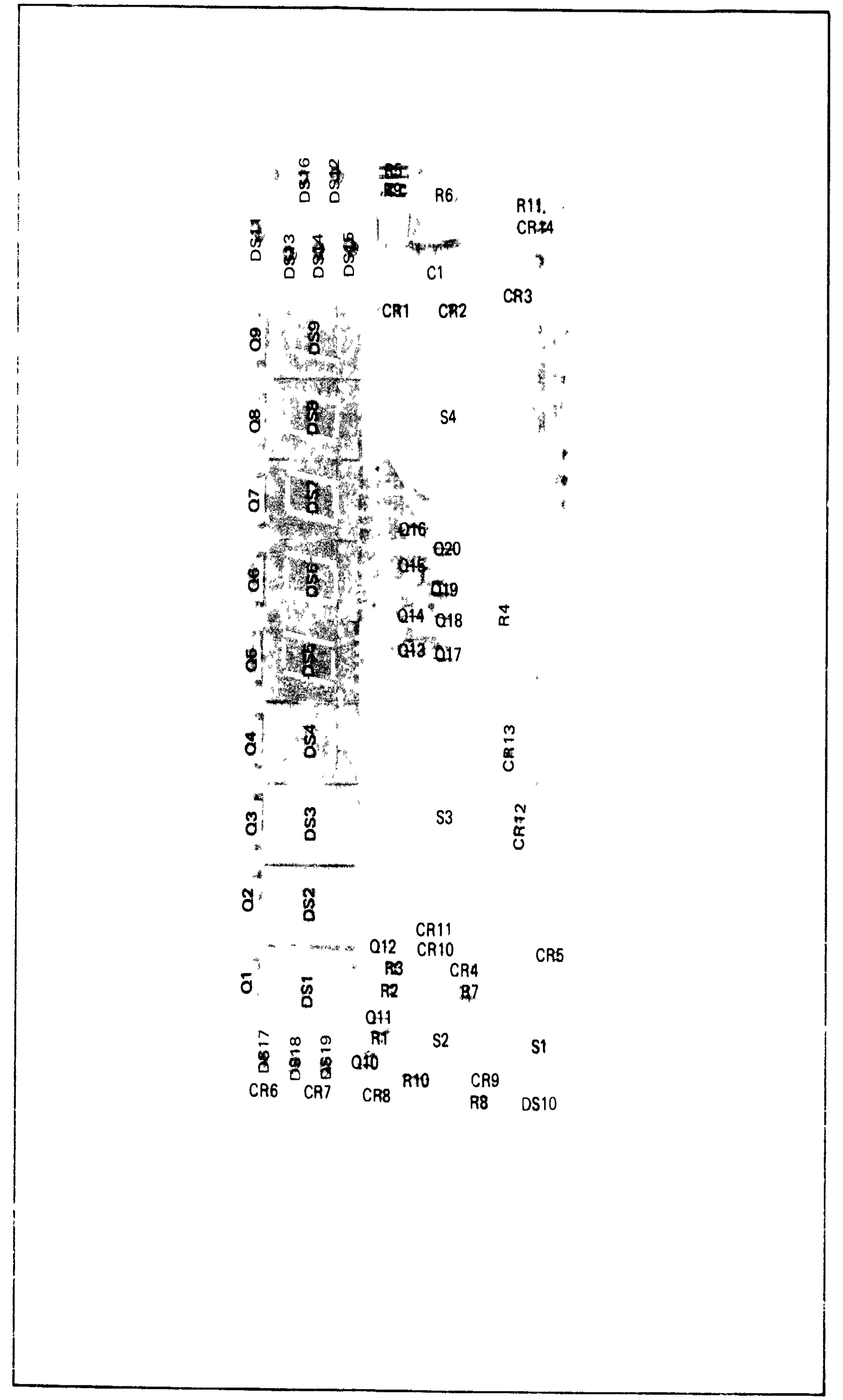


Figure 8-23. A16 Display Block Diagram

P1 PINS

1	–	RM LIGHT	$\overline{1}$	–	GND
2	–	B1	$\overline{2}$	–	LAMP TEST
3	–	B2	$\overline{3}$	–	G LIGHT
4	–	LSWL	$\overline{4}$	–	OF LIGHT
5	–	FC	$\overline{5}$	–	FD
6	–	FA	$\overline{6}$	–	NC
7	–	NC	$\overline{7}$	–	FB
8	–	GND	$\overline{8}$	–	NC
9	–	B3	$\overline{9}$	–	B4
10	–	B5	$\overline{10}$	–	NC
11	–	c	$\overline{11}$	–	NC
12	–	d	$\overline{12}$	–	e
13	–	f	$\overline{13}$	–	NC
14	–	a	$\overline{14}$	–	b
15	–	B6	$\overline{15}$	–	NC
16	–	DP	$\overline{16}$	–	g
17	–	B7	$\overline{17}$	–	B8
18	–	LMRES	$\overline{18}$	–	NC
19	–	ANN	$\overline{19}$	–	+5V = DISABLE, -0.7V = ENABLE
20	–	B9	$\overline{20}$	–	+3.5V
21	–	LSLO NC	$\overline{21}$	–	} POWER SWITCH
22	–	TBS C	$\overline{22}$	–	} POWER SWITCH
23	–	TBS A	$\overline{23}$	–	+5V
24	–	TBS C	$\overline{24}$	–	SRT

P/O Figure 8-24. A16 Display Schematic and Components



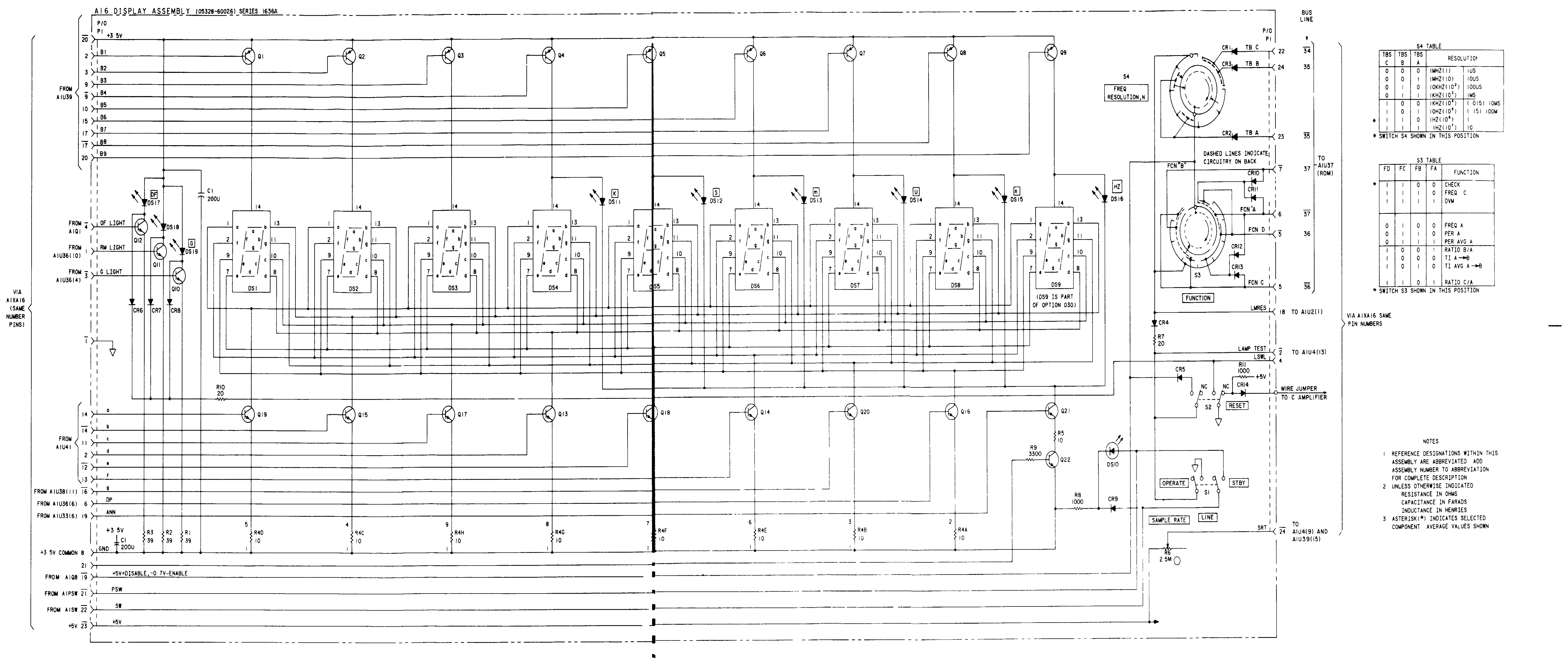
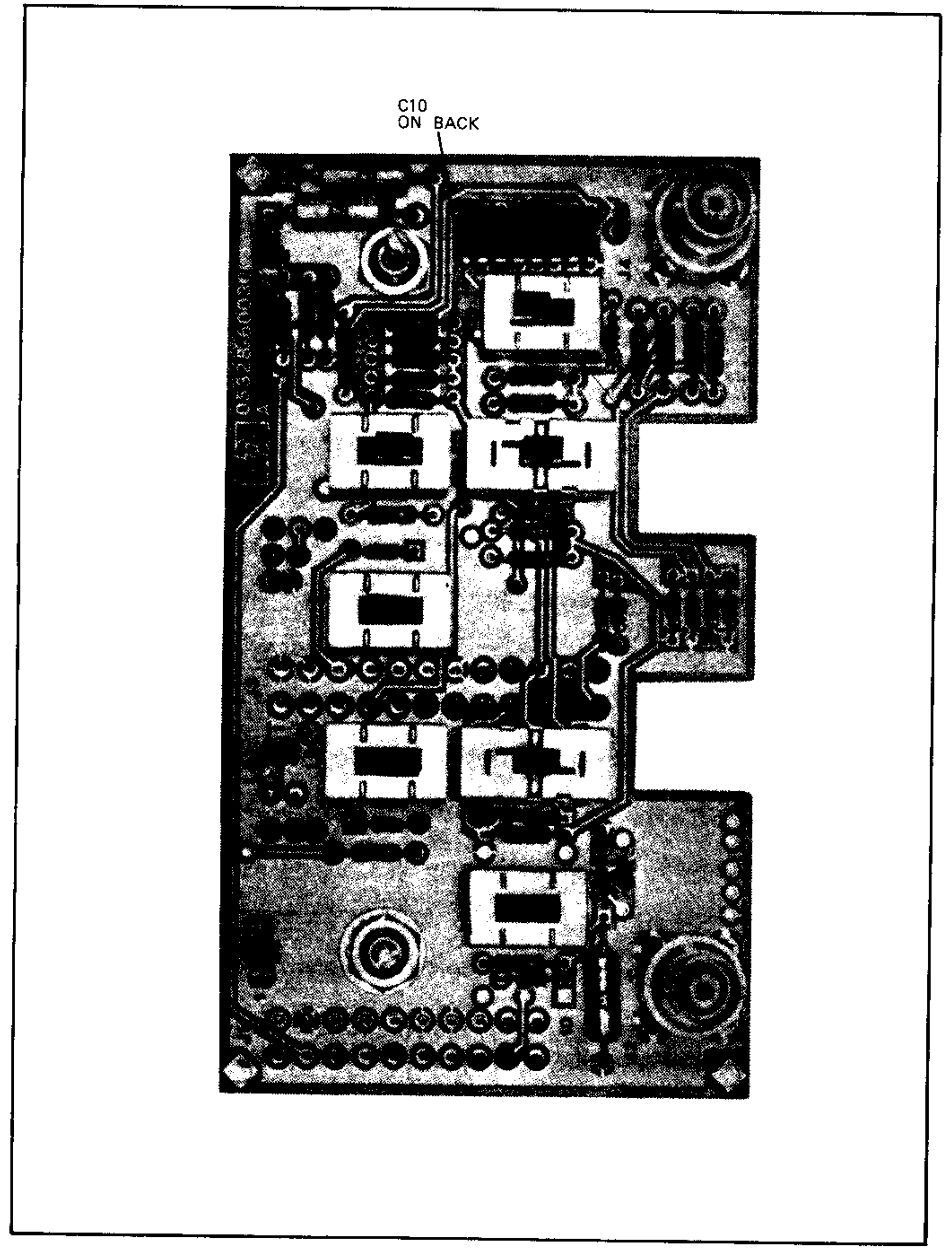
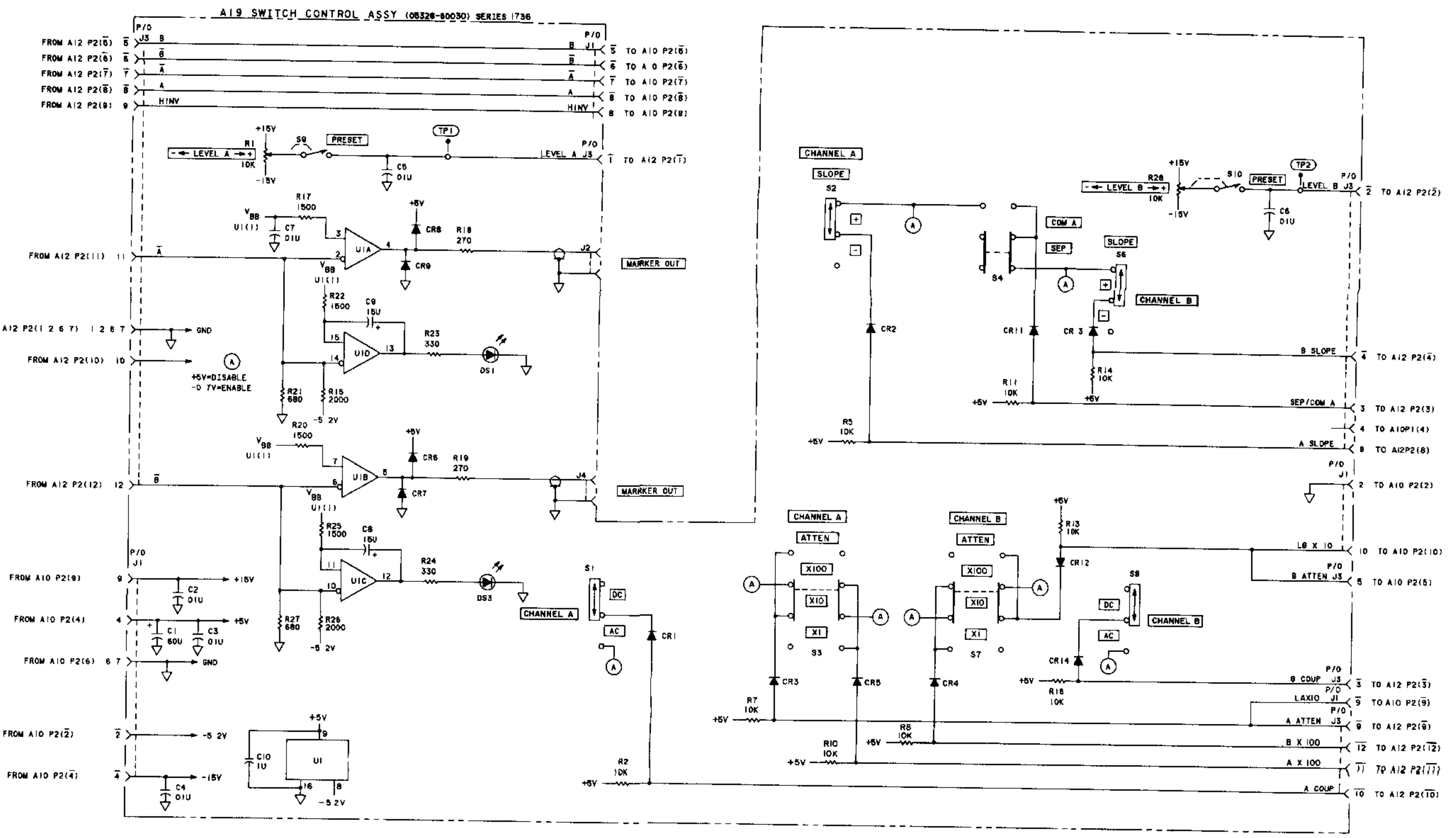


Figure 8-24. A16 Display Schematic and Components





NOTES

1 REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION

2 UNLESS OTHERWISE INDICATED RESISTANCE IN OHMS CAPACITANCE IN FARADS

3 R1 AND S9 ARE PART OF THE SAME COMPONENT

4 R28 AND S10 ARE PART OF THE SAME COMPONENT

Figure 8-25. A19 Switch/Attenuator Schematic and Components

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camo-flauge Pattern Painting of Electrical. Equipment Shelters.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 750-244-2	Procedures for Destruction of electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX B

COMPONENTS OF END ITEM LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists integral components of and basic issue items for the AN/USM-459 to help you inventory items required for safe and efficient operation.

B-2. General

This Components of End Item List is divided into the following sections:

a. Section II. Integral Components of the End Item. These items, when assembled, comprise the and must accompany it whenever it is transferred or turned in. The illustrations will help you identify these items.

b. Section III. Basic Issue Items. These are the minimum essential items required to place the in operation, to operate it, and to perform emergency repairs. Although shipped separately packed they must accompany the during operation and whenever it is transferred between accountable officers. The illustrations will assist you with hard-to-identify items. This manual is your authority to requisition replacement BII, based on TOE/MTOE authorization of the end item.

B-3. Explanation of Columns

a. Illustration. This column is divided as follows:

(1) Figure number. Indicates the figure number of the illustration on which the item is shown.

(2) Item number. The number used to identify item called out in the illustration.

b. National Stock Number. Indicates the National stock number assigned to the item and which will be used for requisitioning.

c. Description. Indicates the Federal item name and, if required, a minimum description to identify the item. The part number indicates the primary number used by the manufacturer, which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items. Following the part number, the Federal Supply Code for Manufacturers (FSCM) is shown in parentheses.

d. Location. The physical location of each item listed-is given in this column. The lists are designed to inventory all items in one area of the major item before moving onto an adjacent area.

e. Usable on Code. Not applicable.

f. Quantity Required (Qty Reqd). This column lists the quantity of each item required for a complete major item.

g. Quantity. This column is left blank for use during an inventory. Under the Rcvd column, list the quantity you actually receive on your major item. The Date columns are for your use when you inventory the major item.

SECTION II INTEGRAL COMPONENTS OF END ITEM

(1) ILLUSTRATION (A) FIG NO.	(B) ITEM NO.	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION PART NUMBER	(FSCM)	(4) LOCATION	(5) USABLE ON CODE	(6) QTY REQD	(7) QUANTITY RCVD
1-1	1	6625-01-061-8929	COUNTER ELECTRONIC DIGITAL READOUT, TS-3662/U 5328A/E42	(28480)			1	
1-1	2	6625-01-061-8905	EXTENDER BOARD 05328-62016	(28480)	INSIDE COVER		1	
1-1	3		POWER CORD 8120-1348	(28480)	INSIDE COVER		1	
1-1	4	6625-01-061-8904	COVER ASSEMBLY 7101-0470	(28480)	INSIDE COVER		1	

SECTION III BASIC ISSUE ITEMS

(1) ILLUSTRATION (A) FIG NO.	(B) ITEM NO.	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION PART NUMBER	(FSCM)	(4) LOCATION	(5) USABLE ON CODE	(6) QTY REQD	(7) QUANTITY RCVD
	1	5920-00-280-8342	FUSE, 1 AMP F. BLO 2110-0001 (28480)				1	
	2	5920-00-793-4592	FUSE, 2 AMP F.BLO 2110-0002 (28480)				1	
	3		MANUAL TM 11-6625-2941-14&P				1	
	4	5920-00-010-5920	FUSE 3 AMP				1	
	5		FUSE 125 AMP 2110-0311 (28480)				1	

APPENDIX D
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

D-1. General

This appendix provides a summary of the maintenance operations for AN/USM-459. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

D-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean (decontaminate), to preseve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipment/components.

D-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a “work time” figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate “work time” figures will be shown for each category. The number of task-hours specified by the “work time” figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the

time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C – Operator/Crew
O – Organizational
F – Direct Support
H – General Support
D – Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item oposite the particular code.

D-4. Tool and Test Equipment Requirements (Sec III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

D-5. Remarks (Sec IV)

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

SECTION II MAINTENANCE ALLOCATION CHART FOR

ELECTRONIC COUNTER AN/USM-459

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT.	(6) REMARKS
			C	O	F	H	D		
00	ELECTRONIC COUNTER AN/USM-459	Inspect	0.1					1	
		Test				1.0		2 thru 9	
		Adjust				1.5		2 thru 11	
		Repair				2.0		2	A
		Overhaul					10.0	2 thru 12	
01	ELECTRONIC COUNTER TS-3662/U	Repair				2.0		2	
		Overhaul					10.0	2 thru 12	
0101	CIRCUIT CARD ASSEMBLY A1 (MOTHERBOARD)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0102	CIRCUIT CARD ASSEMBLY A2 (POWER SUPPLY)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0103	CIRCUIT CARD ASSEMBLY A3 (OSCILLATOR)	Inspect				0.1		1	
		Repair					1.0	2,11	B
010301	OSCILLATOR A3A1	Inspect				0.1		1	
0104	CIRCUIT CARD ASSEMBLY A4 (FUNCTION SELECTOR)	Inspect				0.1		1	
		Repair					1.0	1,2,11	B
0105	CIRCUIT CARD ASSEMBLY A8 ("C" CHANNEL INPUT)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0106	CIRCUIT CARD ASSEMBLY A10 (SYNCHRONIZER)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0107	CIRCUIT CARD ASSEMBLY A11 (DIGITAL-TO-ANOLOG CONVERTER)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0108	CIRCUIT CARD ASSEMBLY A12 ("A-B" CHANNEL INPUT)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0109	CIRCUIT CARD ASSEMBLY A15 (HP-1B INTERFACE)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0110	CIRCUIT CARD ASSEMBLY A16 (DISPLAY)	Inspect				0.1		1	
		Repair					1.0	2,11	B
0111	CIRCUIT CARD ASSEMBLY A19 (ATTENUATOR)	Inspect				0.1		1	
		Repair					1.0	2,11	B
02	COVER, P/N 7101-0470	Inspect	0.1					1	
		Repair					1.0	2	
03	EXTENDER BOARD, P/N 05328-62016	Inspect	0.1					1	
		Repair					1.0	2 thru 11	B
04	POWER CORD, P/N 8120-1348	Inspect	0.1					1	
		Repair					1.0	2	B

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR

ELECTRONIC COUNTER UN/USM-459

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	0	TOOL KIT, ELECTRONIC COUNTER TK-101/G	5180-00-064-5178	
2	H,D	TOOL KIT, ELECTRONIC COUNTER TK-100/G	5180-00-605-0079	
3	H,D	OSCILLATOR, H.P. 652A	4931-00-113-2943	
4	H,D	VOLTMETER, SAMPLING ME-426/U	6625-00-113-3491	
5	H,D	SIGNAL GENERATOR SG-1112(V)1/U	6625-00-566-3067	
6	H,D	OSCILLOSCOPE SYSTEM (MAINFRAME) WITH AMPLIFIER PLUG-IN HP-1402 AND HP-1411	4931-00-491-0261 4931-00-491-0262 4931-00-491-0265	
7	H,D	PULSE GENERATOR SG-1105	6625-01-010-3524	
8	H,D	SIGNAL GENERATOR HP 608 CR	6625-00-487-2878	
9	H,D	POWER SUPPLY PP-7547/U (HP 6113A)		
10	H,D	VOLTMETER HP 3490	6625-01-010-9255	
11	H,D	REPAIR KIT PRINTED WIRING BOARD MK-772/U	5999-00-757-7042	
12	H,D	TRANSISTOR TEST SET TS-1836C/U	6625-00-159-2263	

THE FOLLOWING EQUIPMENTS WILL BE USED WHEN THE PROGRAMING FUNCTION OF THE AN/USM-459 REQUIRES CHECK FOR USE WITH ATE. THIS CHECK WILL BE PREFORMED AT THE CONTRACTORS FACILITY.

GENERATOR/SWEEPER HP-8601A
CONTROLLER/COMPUTER HP-9825A
FUNCTION GENERATOR HP-3312A

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	BY REPLACEMENT OF CIRCUIT CARD ASSEMBLIES A2, A4, A8, A10, A11, A12, A15, A16, AND A19, OSCILLATOR A3, AND CHASSIS MOUNTED COMPONENTS.
B	BY REPLACEMENT OF INDIVIDUAL COMPONENTS.

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

J.C. PENNINGTON
Brigadier General, United States Army
The Adjutant General

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- USAERDAA (1)
- USA ERDAW (1)
- Ft Gordon (10)
- Ft Hauchuca (10)
- Ft Carson (5)
- Army Dep (1) except:
  - LBAD (14)
  - SAAD (30)
  - TOAD (14)
  - SHAD (3)
- Ft Gillem (10)
- USA Dep (1)
- Sig Sec USA Dep (1)
- Ft Richardson (CERCOM Ofc) (2)
- Units org under fol TOE:
  - 29-207 (2)
  - 29-610 (2)

NG: None

USAR: None

For explanation of abbreviations used, see AR 310-50.

* U.S. GOVERNMENT PRINTING OFFICE : 1995 0 - 394-268

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS



SOMETHING WRONG WITH THIS MANUAL?

THEN. . .JOT DOWN THE DOPE ABOUT IT ON THIS FORM, TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

FROM: (YOUR UNIT'S COMPLETE ADDRESS)
Commander
Stateside Army Depot
ATTN: AMSTA-US
Stateside, N.J. 07703

DATE 4 April 1978

PUBLICATION NUMBER	DATE	TITLE
TM 11-5840-340-14&P	23 Jan 74	Radar Set AN/PLC-76

BE EXACT. . .PIN-POINT WHERE IT IS: PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-25	2-28			Recommend that the installation antenna alignment procedure be changed throughout to specify a 2° IFF antenna lag rather than 1°. REASON: Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2° without degradation of operation.
3-10	3-3		3-1	Item 5, Function column. Change "2 db" to "3db." REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.
5-6	5-8			Add new step f.1 to read, "Replace cover plate removed in step e.1, above." REASON: To replace the cover plate.
E-5				For item 2, change the NSN to read: 5835-00-134-9186. REASON: Accuracy.
E-8		E-3		Identify the cover on the junction box (item no. 5). REASON: It is a separate item and is not called out on figure 19.
E-9				Add the cover of the junction box as an item in the listing for figure 19. REASON: Same as above.

SAMPLE

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER
SSG I. M. DeSpiritof 999-1776

SIGN HERE:
SSG I. M. DeSpiritof

TEAR ALONG DOTTED LINE

DA FORM 1 AUG 74 2028-2

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RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS



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TM 11-6625-2941-14&P	28 Mar 79	

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